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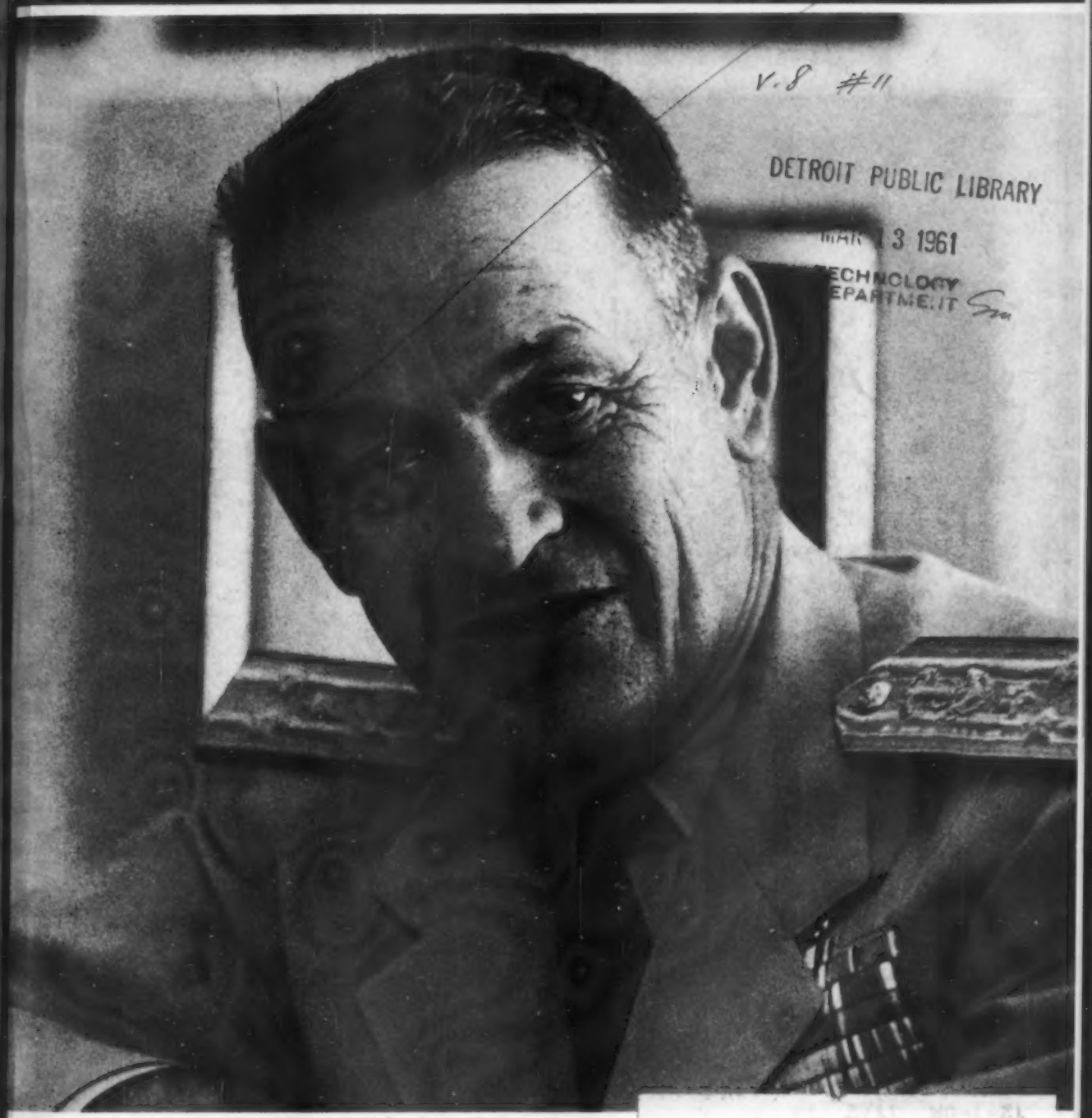
HE MISSILE/SPACE WEEKLY



V. 8 #11

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ECHNOLOGY
EPARTMENT

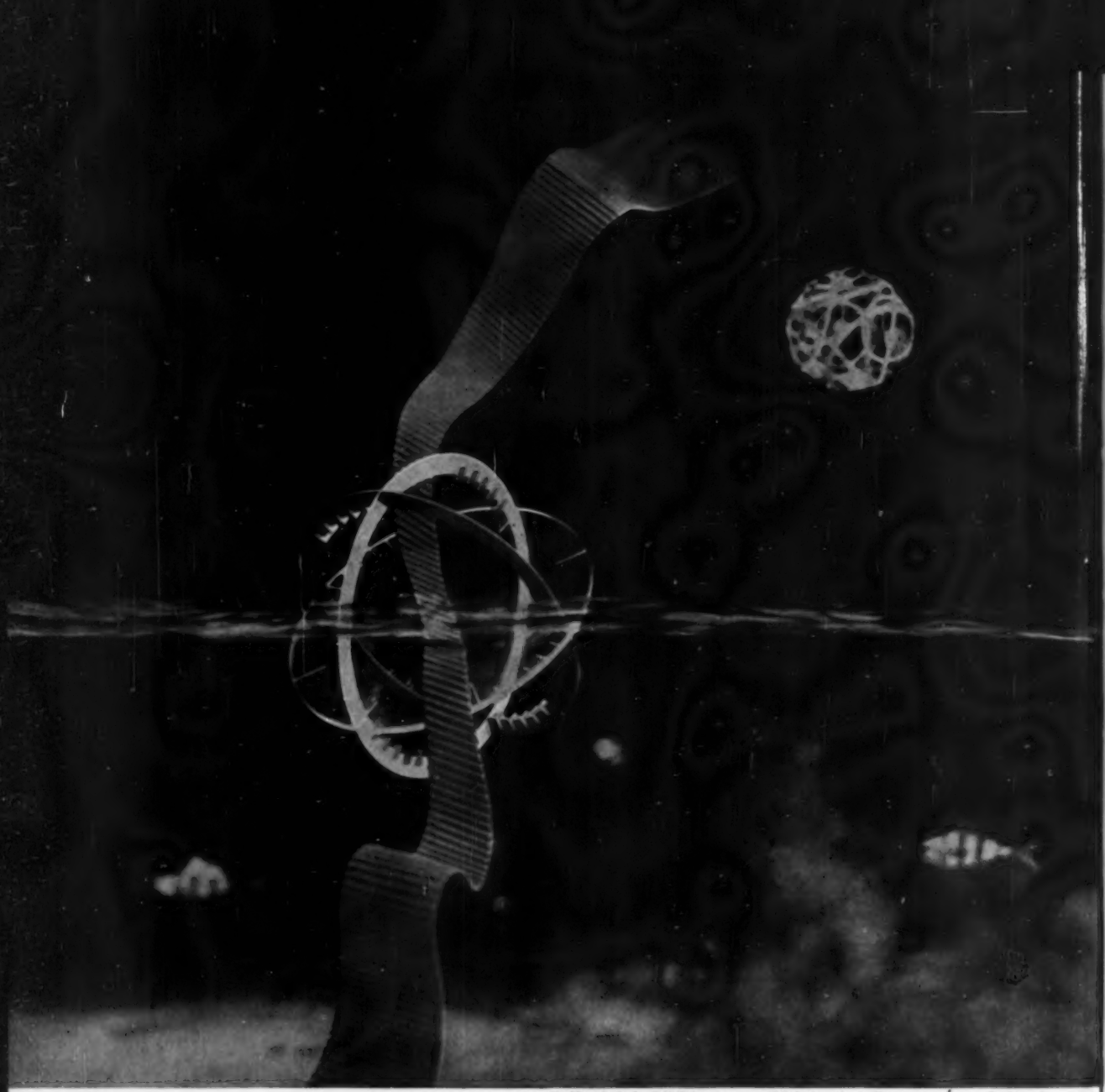
Adm. Hayward: 'Confidence through Blow-ups'

Hayward Calls for More Training Shots ..1

Navy Getting Sub Target Simulators 2

"apco Explores Tungsten Fabrication 36

AN AMERICAN AVIATION PUBLICATION



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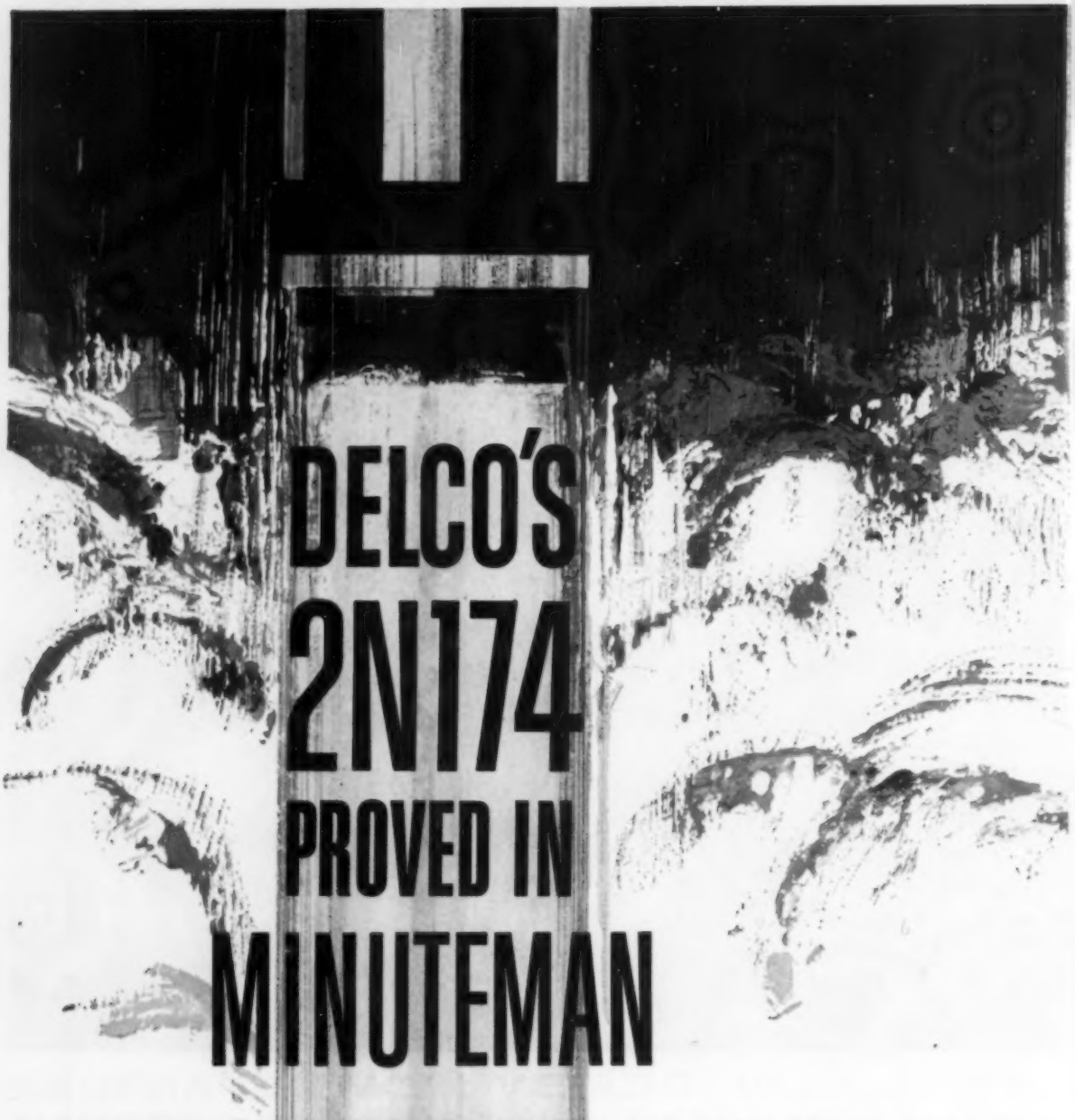

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missiles and rockets

Volume 8, No. 11 March 13, 1961

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THE COVER

Vice Adm. John T. Hayward, Navy R&D chief, says missile training shots must be sharply increased to guarantee reliability. See interview starting on p. 14.

MARCH 13 HEADLINES

Hayward Urges Big Step-up in Training Launches ... 14
Kennedy Administration Renews AF Space 'License' 16
Worldwide Weather Satellite System Blueprinted ... 17
Mace B Bases Near Completion on Japan's Okinawa 18
Lockheed's LMSD Wins Goddard Memorial Trophy .. 19
Orval Cook Says Contracting Must be Overhauled .. 19
Project Banshee to Study Explosions in Near Space .. 40
Blue Scout II Flies with Fourth-stage Guidance 41
A Look at North American's Aerospace Laboratory .. 43

SPACE MEDICINE

GE Develops 200-lb. Water/Oxygen Recycling System 22
NASA Maps Plans for Post-Mercury Manned Launchings 24

ASW ENGINEERING

Navy Getting First Target Submarine Simulators 28
Clevite's 'Oyster'—Rugged Undersea Transducer 29

SUPPORT EQUIPMENT

GE's 'Synchrolink' Swells Telemetry Range 30

OPTICS

Will Laser Lead to Intergalaxial Communications? ..32

ADVANCED MATERIALS†

Tapco Explores Tungsten Fabrication Techniques 36

ELECTRONICS

'Limited War' Is Military Theme of EIA Meeting 38
Support Equipment Controlled by 'Audio-automation' 38

MANAGEMENT

Tulsa Firm Expands Missile/Space Work by Stages .. 42

DEPARTMENTS

Publisher's Memo 6
The Countdown 11
The Missile/Space Week† 12
Technical Countdown . 21
Reviews 39
Names in the News .. 44
Products & Processes . 45
Contracts 47
Letters 48
When and Where 48
Editorial 48

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33,134 copies this issue

MILLS SHEPARD (at left) confers with M/R representatives in New York.

memo from the publisher

WHO ARE YOU, where are you and what do you read? We know, and we thought perhaps you might like to know how we find out.

Like Elmo Roper, George Gallup and Daniel Starch . . . Mills Shepard of Bronxville, N.Y., is a consultant in research. Some 20 businesspaper publishers in all fields of U.S. industry employ Mr. Shepard and his Associates each year to learn more about the readership of their magazines.

Among the publications which Mills Shepard studies are The Iron Age, Printer's Ink, Electrical World, Petroleum Week, Railway Age, Mill and Factory, American Builder and MISSILES AND ROCKETS.

During 1960, M/R published 2146 pages of editorial material covering the missile/space industry, more by far than any other publication.

We like to know what you think of the articles on those 2146 pages.

Here's where Mills Shepard comes in. Six times each year, the Shepard organization sends a team of researchers into the field to talk to M/R subscribers. When 150 field interviews have been completed among people who represent a cross-section of the missile/space industry, both geographically and by job responsibility, the results of these interviews are compiled and sent to us for evaluation.

What do we learn from the Shepard reports? We find out why people subscribe to M/R (most common answer: they're working exclusively on a missile/space project and don't want to wade through a lot of unrelated material) and what they read each week. We know, for example, that nine out of every 10 of you carefully read the COUNTDOWN pages each week. Because you read MISSILES AND ROCKETS to help you in your job, the Products and Processes and Contract Awards sections get higher readership than the Book Reviews or the Names in the News. You like to read our Special Reports, such as those on *Minuteman* (June 6), *Polaris* (July 25), *Titan* (September 5), and *Nike-Zeus* (January 30). Readership jumps on those. That's why we've scheduled more of the same.

Because our circulation reflects the geographic distribution of the industry, there's one chance in two that you live in the West. However, you may well be among the many hundreds of our readers who work at the Pentagon.

Sixty out of every 100 of you are in engineering; almost 30 out of 100 in management. Fourteen out of every 100 of you participate in, or influence, buying decisions on missile structures; 23 out of every 100 do the same for test and checkout equipment; 15 out of every 100 of you have a say in the purchase of electronic subsystems. Almost all of you say you influence purchasing decisions in one missile/space field or another.

Four years ago last October, the first issue of M/R was published and mailed to 4174 paid subscribers. This week's issue will go to 31,509 paid subscribers, and the total is growing at the rate of almost 500 per month.

We keep that total increasing by giving you the information you need and want in your job. So if and when a Mills Shepard interviewer calls on you, help yourself by helping us. The answers you give to the Shepard people enable us to publish a better magazine.

Edward Mukefeld

WET SPACEMAN • The Null-Gravity Simulator—developed by Lockheed/Georgia – rotates submerged spacemen up to 80 r.p.m. to create the effects of weightlessness. This device in the Human Factors Laboratory is just one of the diverse aerospace research and manufacturing capabilities at the Georgia Division.

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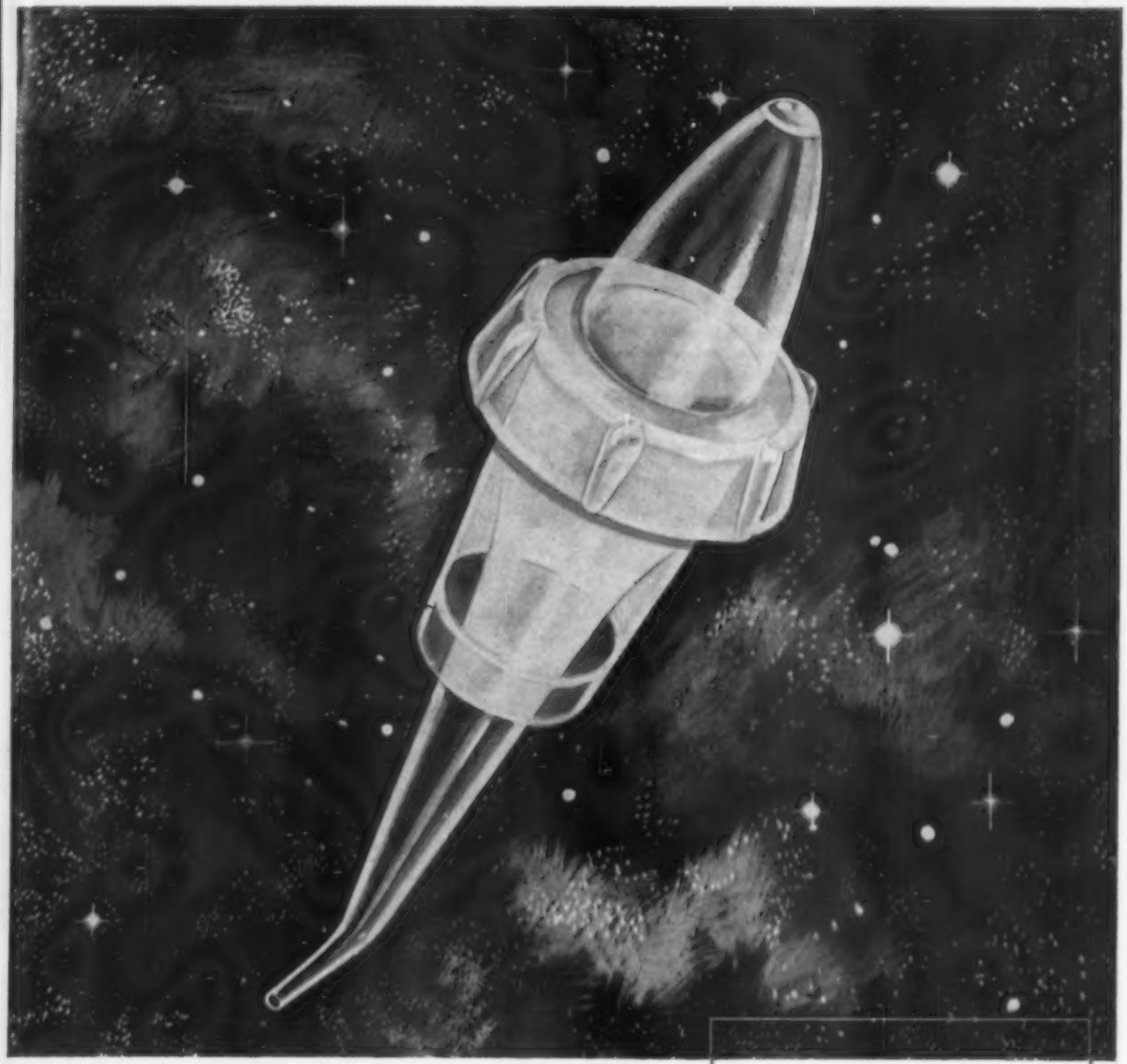

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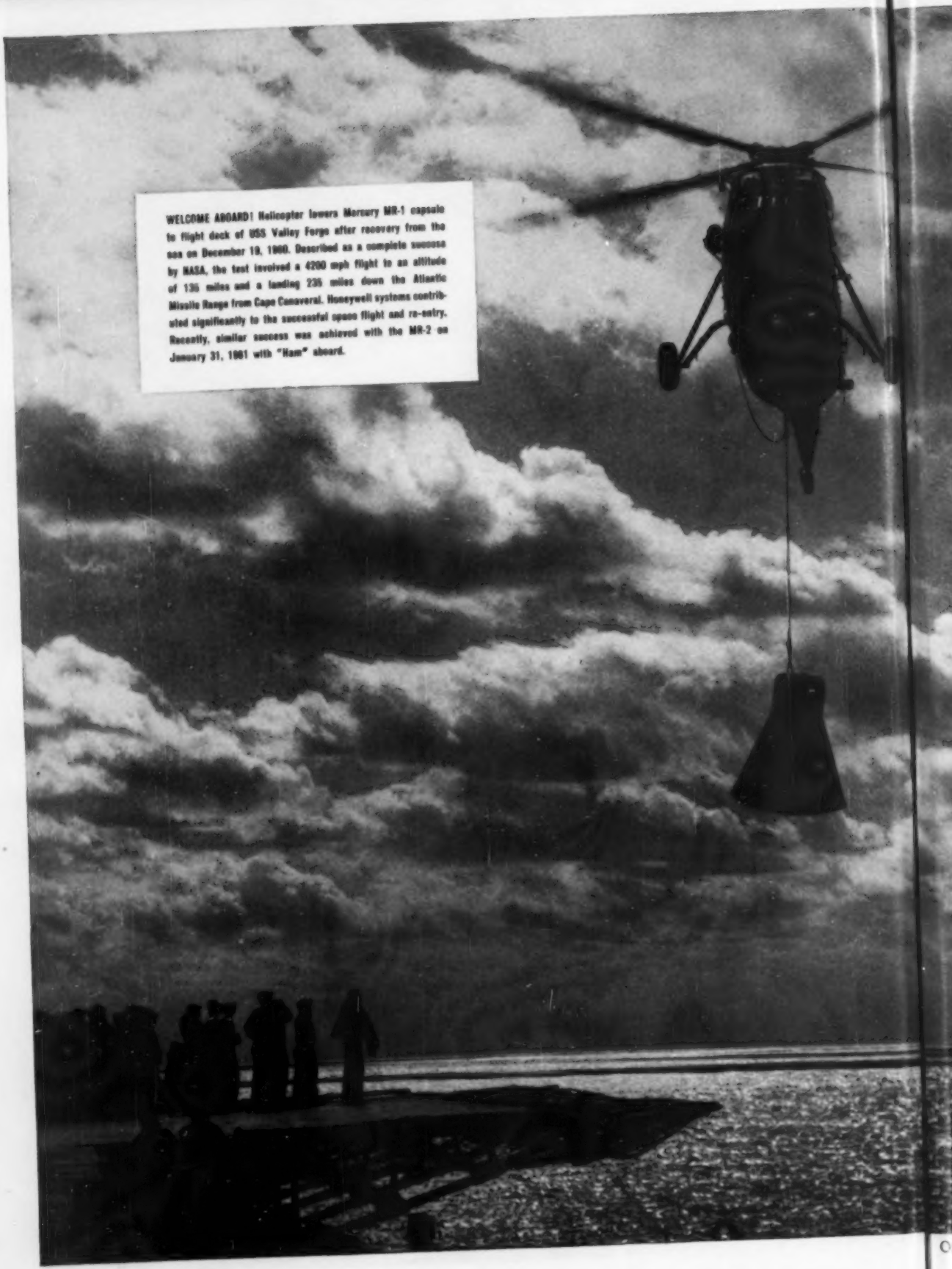

WELCOME ABOARD! Helicopter lowers Mercury MR-1 capsule to flight deck of USS Valley Forge after recovery from the sea on December 19, 1960. Described as a complete success by NASA, the test involved a 4200 mph flight to an altitude of 135 miles and a landing 235 miles down the Atlantic Missile Range from Cape Canaveral. Honeywell systems contributed significantly to the successful space flight and re-entry. Recently, similar success was achieved with the MR-2 on January 31, 1961 with "Ham" aboard.

Official NASA Photo

PROJECT MERCURY: TWO STEPS FORWARD!

Honeywell's Attitude Stabilization and Control System properly sequenced the orientation, deceleration and spinning, essential to the re-entry and safe landing of the Mercury MR-1 and MR-2 ("Ham") capsules.

Project Mercury, NASA's initial manned space flight program, is rapidly nearing the stage at which an astronaut will ride the capsule. Preliminary stages of testing have resulted in refinements that will assure the astronaut's safety and comfort from take-off to touchdown. In the manned shot, just as in these successful tests, Honeywell systems are vitally involved.

Here is how Honeywell systems contributed to the success of the completed MR-1 shot shown at left. After a two minute boost from the Redstone missile, the capsule was separated. The Honeywell Attitude Stabilization and Control System damped out any initial tendency to tumble, in about five seconds, and held the capsule in the attitude of separation. During a five minute period of orientation the capsule was yawed around so that the blunt end (heat shield) was in the leading position. Also, by means of a Honeywell gyro, the capsule was oriented with the blunt end elevated 14° from a perpendicular to local vertical. Later this orientation was changed to 34°, and the retrorockets were fired for two minutes to reduce speed by 350 mph. The capsule was then aligned to a very shallow re-entry angle. Upon sensing a 0.05G deceleration, the system started the capsule spinning at a rate of 10°/sec. At 21,000 feet altitude, a parachute was deployed and the control system disconnected.

This carefully programmed sequence was sensed and controlled by extreme-precision Honeywell gyros and related circuitry in the system. Functions of the system were telemetered to the ground for study in preparation for the manned capsule flight. Additional information was gained from the "Ham" shot. The astronaut will have the option of using manual controls to override the automatic system control.

The manned flight will also carry a Honeywell Attitude and Rate Indicator System which provides the astronaut with information on capsule attitude, rate of attitude change and a reference for controlling attitude. A Honeywell Earth Path Indicator will provide continuous information of the location and direction of travel in relation to the surface of the Earth. A Honeywell Humidity Indicator will keep the astronaut posted on the humidity condition.

Project Mercury is just one of the important missile and space programs for which Honeywell is providing guidance, control and stabilization systems. Others include Centaur, Scout, X-15, Agena B, Thor-Delta and Polaris. Honeywell is also Prime Contractor on ASROC and Associate Prime Contractor on Dyna Soar. To learn how Honeywell can assist with systems integration and management programs, contact your nearest Honeywell representative, or write: Honeywell, Aeronautical Division, 2600 Ridgway Road, Minneapolis 13, Minnesota. *Sales and service offices in all principal cities of the world.*

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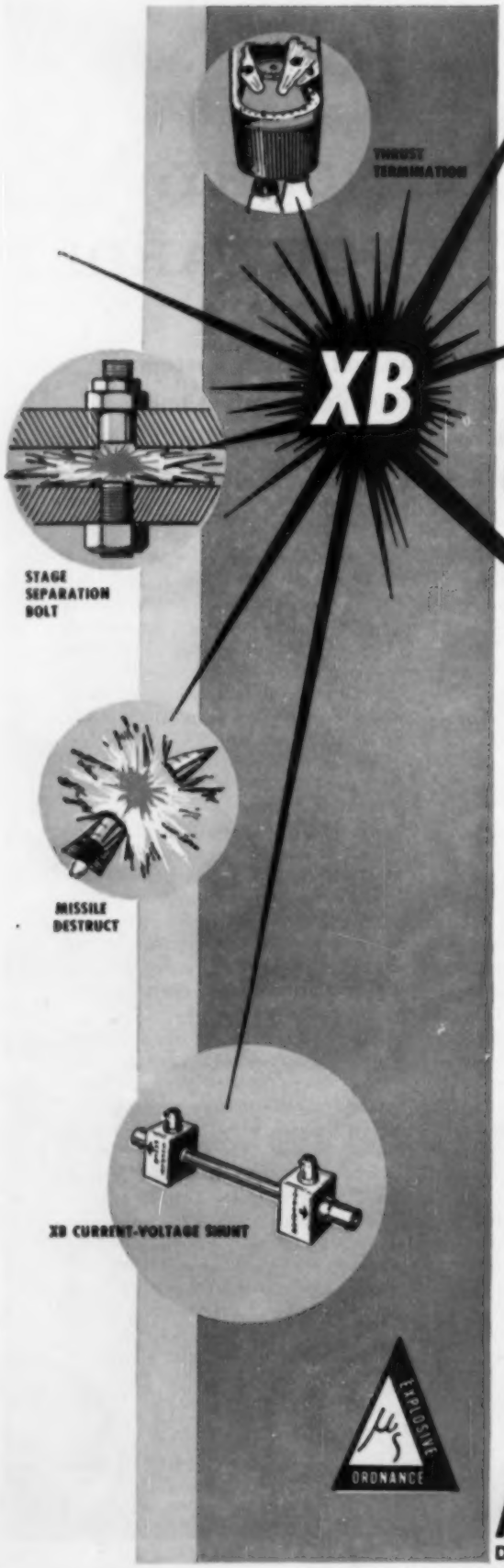

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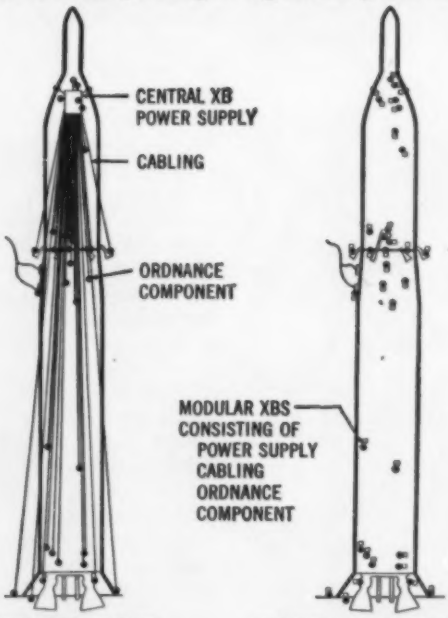
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The Countdown

WASHINGTON

Votes for NASA

COUNTDOWN hears some powerful congressional figures are urging Kennedy to maintain a strong civilian space effort in NASA. The main reason: propaganda. Russia has succeeded in cloaking the military nature of its space activities. If all U.S. space programs are turned over to the military, the Russians will be handed the advantage as the "peaceful" space explorer in world opinion.

McNamara Gets Warning Sign

Chairman Moss of the House Information Subcommittee is warning Defense Secretary McNamara there may be "grave danger" the public will get less DOD information under the Kennedy Administration. The sore point: McNamara's new investigation of the DOD information system, ordered as the result of recent news "leaks." In an exchange of letters, Moss said the investigation could bring about the imposition of outright "censorship."

Is Anyone Listening?

Military men are ready to deny charges that they are not receptive enough to new ideas for weapons—a complaint being voiced by scientists. The House Space Committee is quite seriously concerned with the charge, and has ordered extensive staff studies which could lead to early hearings.

Hearing Gaps and Missile Gaps

The Democratic-run Congress is not making any effort to hurry up public measuring of the Missile Gap. Actually, plans for all hearings that could become conspicuous are marking time until Kennedy points the way.

Pershing Being Pushed

Big drive is on by the Army to move up to summer the operational date of the solid-fueled *Pershing*. Success of a new inertial guidance system in a March 3 shot may be the key to the speed-up. Original deployment date was late this year.

Third Polaris Sub Almost Ready

The Robert E. Lee is expected to go on war patrol about Easter—increasing the number of *Polaris* subs standing guard off Russia to three. The Navy hopes to have several more on combat station this year.

Long Beach Polaris Out

Word is being spread that Defense Secretary McNamara has killed the last-minute decision by Ex-secretary Gates to put eight *Polaris* missiles in the nuclear-powered cruiser Long Beach. The reason is the $55-million cost—which would buy half of a far less vulnerable submarine.

INDUSTRY

ICBM Base Cost: $1.3 Billion

Figures made available by Congress this week estimate the total ICBM base construction cost (brick and mortar only) at $1.3 billion. The breakdown: 13 *Atlas* squadrons—$475 million; 14 *Titan* squadrons—$602.6 million; 9 *Minuteman* squadrons—$240 million. All of the *Minuteman* money is based on a cost of about $500,000 per silo, a figure which is being revised. About $246 million remains to be obligated to finish *Atlas* and *Titan* base construction—including $75 million for two *Titan* squadrons at Griffiss AFB, N.Y.

New Competition: Glass Motor Cases

Number of companies developing a glass wrap capability is on the rise. This is borne out by the array of manufacturers—Rocketdyne, Allison and others—who are competing to second-source the second stage of *Polaris A-2* which is now being produced by Aerojet for Hercules.

R&D Intelligence

Latest suggestion for solving the problem of moving large quantities of helium around the country to ICBM bases is to liquify it (at –452°F). This would eliminate bulky pressure tanks and reduce losses through leakage . . . Research to make beryllium more workable is on the upswing . . . Goodyear has come up with an inflatable fabric doughnut-shaped ring to cushion a space vehicle for a lunar or planetary landing . . . North American Aviation is pushing research on refrigeration systems to prevent an astronaut from broiling in the 213°F heat the sun produces on the moon.

Thought of the Week

To any company thinking of "getting in" defense work there is this word of advice from Westinghouse Vice President E. V. Huggins: "Misguided enthusiasm to take on military work just for the sake of having it in-house can be destructive to both the contractor and the military. Above all, a company must put its effort where it will do the most good for the country . . . Military business cannot take second place to the commercial—if you want to stay in it."

INTERNATIONAL

New Steam for NATO MRBM

Expect NATO governments to take a step soon toward acquiring a medium-range ballistic missile—either *Polaris* or *Pershing*. The deciding factor appears to be the swing behind President De Gaulle's view that NATO can no longer rely as fully as it has on U.S. strategic nuclear forces in a purely European war.

Overseas Pipeline

Japan is getting inquiries from Argentina, Burma and Australia on possible purchase of its *Kappa-6* sounding rockets for weather research . . . Britain will control the nuclear warheads for the *Skybolts* it buys from the U.S. —by using its own . . . Rumors are spreading that the Royal Air Force will soon scrap the air-to-air *Firestreak* . . . NATO representatives are debating whether they should buy Nord-Aviation's *Bullpup*-like *AS-30*.

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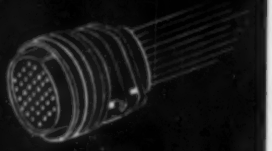

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The Missile/Space Week

House Okays NASA Funds

A supplemental Fiscal Year 1961 appropriation of $49 million for NASA is before the Senate.

The House—traditionally the toughest Congressional stumbling block—approved all but $606,000 of the $49.9 million sought by former President Eisenhower for NASA R&D along with his FY '62 budget proposals.

The House left it to NASA to decide where to apply the "token" reductions. It also approved $500,000 of a $1-million request for additional authority to spend already-appropriated funds on travel.

Meanwhile, a NASA spokesman predicted work will be completed this week or next on revising the FY '62 budget to conform with the new Administration's requirements.

Satellite Debate Stirs

Two giants of the communication business—American Telephone & Telegraph Corp. and the Radio Corp. of America—are at odds about the best technical approach to a commercial communication satellite system.

In briefs filed with the Federal Communications Commission last week, RCA came out for 24-hour-orbit synchronous satellites at 22,300 miles altitude, while AT&T renewed its proposal for satellites in 1000-3000-mile orbits, which it already has temporary FCC authority to operate. Both companies propose active repeater satellites.

Several other companies proposed in briefs that the ultimate system of commercial satellites should be owned jointly by all common carrier concerns using the facilities. The Justice Department, moreover, questioned whether single ownership would violate antitrust laws.

Meanwhile, Space Technology Laboratories won a three-year $2.7 million Army contract to provide systems engineering support and technical consultant services on Project *Advent*, the Army's program for developing a military 24-hour communications satellite.

And in a speech Tuesday, Richard S. Morse, assistant Army secretary for research and development, said a review of Army and National Aeronautics and Space Administration plans will be necessary to make certain duplication is avoided.

X-15 Pilot Breaks Record

Maj. Bob White became first to fly four times the speed of sound when he guided his *X-15* to top speed of 2905 mph.

NASA said he flew the 57,000-lb.-thrust engine at two-thirds throttle.

Next flight, scheduled to be made by NASA pilot Joe Walker, may test altitude capability of the larger engine.

RCA'S PROPOSED communications satellite shown in artist's conception.

Patrick Henry Reaches Loch

A new underwater record of 66 days, 22 hours, was set by *Polaris* sub Patrick Henry on patrol in the waters of Russia.

The sub emerged at Holy Loch, Scotland, in the midst of demonstrations by Scottish pacifists. The sub tender Proteus arrived at Holy Loch last week.

Now on station is the *Polaris* fleet sub George Washington.

Probe Lost for Lack of Data

Russia's loss of contact with her Venus probe at less than 4 million miles leaves the long-distance radio communication record with the U.S. —by a factor of five.

The Soviet news agency Tass said Russian trackers failed to establish contact Feb. 27, just 15 days after launching.

The 250-ft. dish at Britain's Jodrell Bank tracked America's *Pioneer V* out to 22½ million miles last year. Dr. A. C. B. Lovell, observatory director, said the Soviets never gave him enough information to track their probe successfully.

Meanwhile, NASA gave these elements for the probe's orbit—calculated by other U.S. agencies on the basis of Russian statements: period 300 days, inclination 0.3 degrees to ecliptic, aphelion 1.019 astronomical unit, perihelion 0.7183 a.u.

'Big Boy' Igniter Disclosed

An igniter developed for Air Force's Project 3059 and other million-lb.-thrust class solid boosters is a 50,000 lb. thrust device dubbed "Big Boy."

Aerojet-General Corp. reveals the pyrotechnic device was used to ignite its 400,000-lb.-thrust "Bimbo" motor, a sub-scale segemented solid rocket. The igniter, which is 20 in. long, fired a controlled flame down the center of the core. A 70,000-lb.-thrust igniter is currently in the design stage by Aerojet for bigger motors.

Three Years in Space

Vanguard I, the smallest satellite although one of those most useful to science, is completing its third year in orbit still beeping away.

The solar-powered signal from the 3¼-lb. aluminum sphere has enabled trackers to follow its path in extremely fine detail, permitting geophysicists to gather a rich harvest of new information about the earth and the characteristics of the space since it was launched March 17, 1958.

The *Vanguard* program, which cost $95 million, also produced some fallout in the form of technology applied to further rocket programs and retooling the Atlantic Missile Range from missile development to space.

Scientific results include:

–Discoveries that the earth is slightly less oblate than previously believed, and that there is a pear-shaped distortion raising the sea level at the north pole 100 ft. higher than at the south pole.

–Proof that the orbit of a satellite is affected by solar wind, the pressure of sunlight, the earth's magnetic field, the wispy atmosphere above 400 miles and the gravitational fields of the sun and moon.

As for rocket technology, *Vanguard* provided a second stage widely used in the *Able* programs and still in use with modifications as *Delta* and *Able Star* and a third stage used in *Scout*, which pioneered development of high-energy final stages for the *Polaris* and *Minuteman* missiles. The first *Vanguard* third stage was the largest solid rocket of its day.

Vanguard pioneered the technique of coasting between stage firings, designed to obtain more circular orbits—something Russia never attempted until its orbital launching of the Venus probe last month.

Firing the first solid rocket in space, *Vanguard* learned about "chugging"—the tendency of solids to ignite for a brief burst sometimes several minutes after burnout. It was a "chug" from the final stage that bumped the rocket case against *Vanguard II* and caused it to wobble, spoiling the signals.

CV Gets Saturn Tanks

Chance Vought Corp., Dallas, Tex., will manufacture 42 tanks of 70-in. diameter for *Saturn* boosters 6 through 10.

The National Aeronautics and Space Administration chose Chance Vought last week for negotiations on a contract estimated at $2 million, calling for delivery beginning in April 1962. The three other final bidders were Boeing Airplane Co., the Martin Co. and Chrysler Corp.

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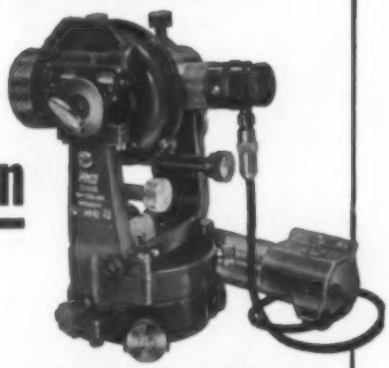

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Remember the torpedoes . . .

Hayward Urges Big Step-up In C

by James Baar

VICE ADM. John T. Hayward, Deputy Chief of Naval Operations for Development, is urging a sharp increase in the current rate of missile training shots in order to ensure reliability in time of war.

"If the country is going to put confidence in its missiles, we have to be able to operate the systems more than we are," Hayward said in an interview with MISSILES AND ROCKETS. "We simply have to fire more missiles."

The admiral's statement underlined a key problem that has deeply concerned top officials in both the Navy and Air Force. At the same time, the admiral pointed to other significant R&D problems and trends. He said:

–"We must get a cheap HE surface-to-surface missile or we may have to go back to guns in the 1965-75 time period. We have discussed this with industry at great length. So far we have not been able to get one. The Russians have air-breathing surface-to-surface missiles. Maybe we were wrong in getting rid of ours so fast."

–"Communications may be the real answer to ASW. The ship, the plane and the sub each have individual qualities that the other two do not. If the sub can talk to the ship and to the plane as a closely knit team we may have what we need."

–"The solution to the sub-launched missile certainly is not apparent. *Typhon* is the first system to have any capability against a sub-launched missile. But the problem is very tough. For example, if a sub 35 miles away launches a missile at your ship you have to acquire and shoot down that missile in 27 seconds. There is the controlling factor."

–"More and more nuclear-powered surface ships are going to be built because nuclear power is going to become economically competitive from a military standpoint. On the other hand, the manned airplane is going to remain. The flexibility of man is most important. You have to be able to deliver with preciseness and flexibility which a missile does not possess. You don't want to incinerate your friends."

• **Training scoreboard**—Hayward talked easily in his usual forceful, blunt tones as he sat in his office on the Pentagon's top floor. Pictures and models of Navy missiles and aircraft decorated the room. Behind him on the wall was a dartboard labeled: "Top Level Decision Maker." It was divided into diamonds marked "yes" and "no."

While talking, the 52-year-old admiral leaned slightly forward in his chair and made short swivels back and forth. He gave the impression of being a tightly coiled, high-precision administrator tooled according to his own design. Two essential components obviously were brains and a sense of humor.

Hayward returned several times to the need for more missile training shots.

At present, the number of big strategic missiles provided by the defense budget for training launchings is very limited for economy reasons. Each *Polaris* costs about $1.1 million; each *Atlas*, about $2 million. The funds available do not go far.

In all, there have been only nine *Atlas* training shots since the first on Sept. 9, 1959, from Vandenberg AFB, Calif. Five were successful; one, partially successful; three failed.

Only 15 *Polaris* training shots have been launched since the first off Cape Canaveral on July 20, 1960. All 15 cleared the surface of the sea after being fired from submerged submarines. Ten made successful flights; five failed.

• **Data demand**—As a result of this paucity of operational training launches, many military men including Hayward feel that the military crews are unable to gain sufficient confidence in the missiles that they man. Moreover, there is the problem of obtaining sufficient performance data from operational launchings in order to plan targeting and deploy sufficient forces to accomplish missions.

In the opinion of some, the second need is far greater than the first. As one Air Force official put it:

"We don't really need to launch a missile to train a man. Once he has lit the match I say he has done it. But the

- ***Either the Navy gets cheap HE missile or "we may have to go back to guns"***
- ***The antimissile problem: ships given only 27 seconds to react against sub***
- ***Look for more surface ships to be nuclear-powered; the airplane will stay***
- ***AF also worries about the reliability factor--could fire more missiles***

ICBM Training Shots

decision makers have to have performance statistics in order to have any confidence in a weapon. The weapon has to be statistically reliable.

"In other words, I'm not going to pull a bomber out of the force and replace it with four or five missiles unless I know the missiles are going to do the job. Only data from many operational firings will tell me that a missile is going to work and how reliably. Otherwise I'm only operating on a designer's assurance."

Others disagree that actual launchings are unnecessary for training in itself.

"It's a matter of practicing operation of a weapon under combat conditions or conditions as close to combat as possible," one officer said. "The more you do it, the more confident you are that you can. More unknown bugs are removed. And the whole system becomes more reliable. Turn it around and the picture is precisely what you think it would be."

Practicing this kind of training would be very costly—conceivably running into hundreds of missiles.

• **Lesson in torpedoes**—*Polaris* submarines coming in from their stations can stop at Cape Canaveral and their missilemen can use their own equipment to launch a number of the missiles that they have been maintaining. For all practical purposes, such launchings can be done under combat conditions.

The closest that the Air Force can come to this is to ship missiles and the crews that have been maintaining them back to Vandenberg. Then the crews would launch the missiles with similar equipment.

Hayward said the training shot problem today is comparable in many ways to the torpedo problem that existed before World War II.

"Torpedos then were so secret and so expensive that we just didn't launch many of them," he said, shrugging. "The results were not good after the war started."

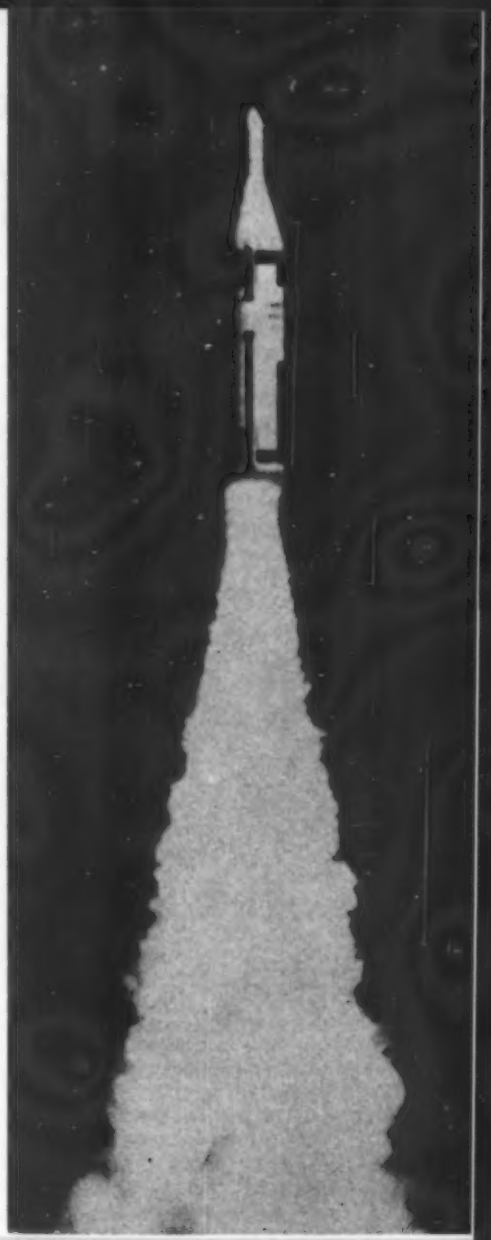
Hayward's statement was nothing if not kind. The results actually were disastrous.

"United States torpedoes were variously described as running too deep, not exploding, exploding too soon, or not packing enough punch when they did explode," according to an official Navy report.

At another point the report said: "The problem was compounded by the Bureau's (Ordnance) reluctance to accept the fleet evaluation of its weapon. This reluctance was born . . . from misplaced confidence in its own past work."

Hayward pointed the moral succinctly.

"To be sure of what you have, you have to let it go all the way and blow up. Frequently." ⠿



Hayward Next CNO?

NOT LONG AGO one of the Navy's big P2V Neptune patrol bombers roared from the deck of the Carrier Midway in a perfect takeoff, but when the pilot prepared to land again he was ordered to let the co-pilot do it.

The Navy's reasoning was sound. The pilot was too valuable to the Navy to take unnessary risks. He was Vice Adm. John T. Hayward, Deputy Chief of Naval Operations for Development and widely considered to be one of the top candidates to succeed Adm. Arleigh Burke as the next Chief of Naval Operations.

The admiral who stuck his grizzled crew-cut head out of the Neptune and then jauntily swung down onto the Midway's deck had been designated a naval aviator since 1932. Since then he has flown more than 13,000 hours.

During World War II, Hayward commanded a bombing squadron and was awarded a Distinguished Flying Cross and Purple Heart. But in 1944 his career took one of its most significant turns. He became an experimental officer at NOTS, Inyokern, Calif., where he worked on rocket projects and the atomic bomb. It was the beginning of his naval career as a noted nuclear physicist.

Before becoming head of all Naval R&D in 1957, Hayward moved back and forth between technical assignments and sea duty. Among other posts he worked for the AEC and commanded the Naval Ordnance Laboratory.

Hayward is known for putting in gruelling days that begin about dawn and run into the night. He invariably carries stuffed briefcases home to his quarters at the Naval Weapons Plant where he lives with his wife and three children.

Another Hayward specialty is his annual series of appearances before congressional committees. His comments are always succinct, informative and often bloody.

Hayward has always been a good athlete. At Annapolis, he became an All-American water polo player. These days he confines himself mainly to playing par golf. He plays a good game both physically and psychologically.

"His golf is always better because yours is worse," one Naval officer who often plays with him grumbled recently. "It's decided before he tees off who is going to win." ⠿

McNamara Renews Air Force Dominance of Military Space

New directive gives AF job of directing 87% of DOD's space effort; some Army & Navy plans may suffer

DEFENSE SECRETARY Robert S. McNamara has renewed and strengthened the Air Force's license as the nation's central and all-but-sole military space agency.

McNamara put in an official directive what has been fact for some time: Almost all military space programs—87%—are under the direction of the Air Force.

The proposed FY '62 defense budget provides $850 million in obligations for astronautics. The Air Force will pass out 91% of this either for itself or other agencies.

The McNamara directive assigned RDT&E for all future space development programs or projects to the Air Force—with only one loophole. It said that he or the Deputy Defense Secretary might make "exceptions . . . in unusual circumstances."

The directive specifically authorizes all three services "to conduct preliminary research to develop new ways of using space technology to perform . . . assigned functions."

But it was made clear that "preliminary research" would be tightly controlled by the Defense Director of R&E to make sure that it remained preliminary. The principal weapon here will be control of funding.

The directive said that all proposals for space R&D projects beyond the preliminary stage must be approved by the Defense Director R&E and the Defense Secretary. Once approved, the projects will be passed on to the Air Force.

McNamara said in a sparate memorandum to the Pentagon top command that the assignment of space R&D projects to the Air Force "will not predetermine the assignment of operational responsibilities for space systems." However, he said such assignments will "take into account the competence and experience of each of the services and the unified and specified commands." Since the Air Force would be the developer, its "competence and experience" seemed to give it something of an edge.

The new directive will not affect the Navy's *Transit* navigation satellite or the Army's *Advent* communications satellite R&D programs—the only major military satellite programs outside the Air Force. But the directive appeared to undercut a number of new space programs that the Army and Navy have had in mind.

• **Possible casualties**—The most prominent among these are the anti-satellite proposals and studies that both the Navy and Army have been reviewing. The Navy has proposed the development of a seaborne anti-satellite missile. The Army has considered the conversion of *Zeus* batteries to anti-satellite work.

Both services also have considered the development of their own reconnaissance satellites. And the Navy has pressed for development of a satellite launch ship possibly equipped with *Polaris* boosters.

It was not immediately clear whether any of these projects might come under the "unusual circumstances" category.

The McNamara directive was described as a "further projection" of a policy memorandum issued by Defense Secretary Neil McElroy in 1959. The McElroy memorandum gave the Air Force the responsibility for the development, production and launching of military space boosters. But the assignment of payloads was to be made among the services. As it turned out, *Transit* and *Advent-Courier* were the only ones ever assigned outside the Air Force.

McNamara said in his memorandum that he issued this space directive to achieve "better organization and clearer assignment of responsibility." He said he felt this would "much improve . . . the military portion of the national space program."

A number of Navy and Army officers said privately that the directive might lead to some economies but it also would tend to slow up the development of any space system not clearly designed for the Air Force.

As one official put it: "Can't you see the Air Force knocking themselves out for a Navy project if an Air Force project is in need of attention?"

The directive generally followed a recommendation made earlier in the year by President Kennedy's Ad Hoc Committee on Space. The committee said "a single responsibility within the military establishments for managing military portion of the space program" should be named.

Now that McNamara has done it the question that arises is how much of the overall national space program the "single responsibility" will be given by the Kennedy Administration.

Some indications are expected to come when Kennedy sends his new defense proposals to Congress—probably within the week. ⌗

Probers Score Base Costs, Delays

HOUSE INVESTIGATORS are standing firm for the present method of lump-sum contracts for construction of ICBM bases.

The pleas of base-builders for "cost-reimbursement-type" contracts were brushed aside by the House Appropriations Military Construction Subcommittee, which has been holding hearings on rising costs and lagging completion dates of ICBM bases (M/R, March 6, p. 14).

The House probers say the lump-sum approach sets realistic prices—and both the Defense Department and its contractors should therefor strive to live with it.

Both DOD and the contractors have been chastized during the hearings. The Committee declared that the heart of the problem was "division of responsibility" coupled with an "abnormally large number of change orders." It called for Pentagon appointment of a single, overall director of the huge missile-base program.

"Congress has made available in excess of $1.5 billion for this construction," the Committee said. "The Fiscal Year 1962 budget contains a request for $251,900,000, and undoubtedly additional funds will be required in Fiscal Year 1962 and in future years."

To help contractors work under the lump-sum method, the Committee recommended that closer coordination be established between the designer and manufacturer of equipment and the design and construction personnel. It decried ivory-tower estimates of costs, and called for estimates by professionals familiar with the problems involved.

The military was advised to let the builders know when design changes appear probable, so that the construction schedule can be altered if necessary at the least cost to the taxpayer. In addition, the Committee said, realistic cost estimates of changes must be made before they are actually undertaken.

The investigators recommended that every major change be brought up at a conference where all interested parties are represented. At this gathering, it said, everyone involved should consider the effects of the change on costs and on the construction timetable. ⌗

$100 million a year . . .

Weather-Satellite Birth Pains

Plans for U.S.-operated worldwide systems must win approval of committees, President and Congress to be operational by FY 1963

by Jay Holmes

AN INTERAGENCY committee hopes to blueprint within the next few weeks an operational worldwide weather satellite system—to be run solely by the United States until such time as there is international agreement. The cost probably will exceed $100 million a year.

A subcommittee of the National Coordinating Committee for Aviation Meteorology (NACCAM) which is doing the work is headed by Dr. Francis W. Reichelderfer, chief of the U.S. Weather Bureau.

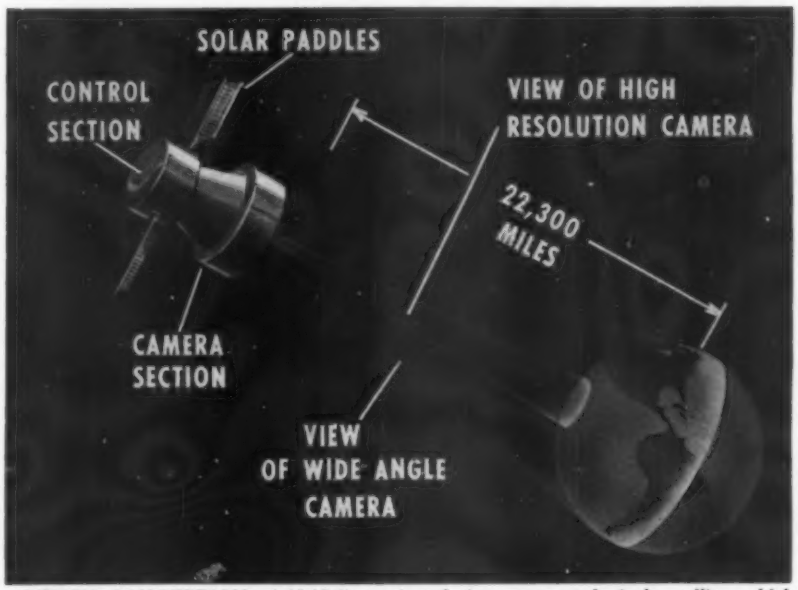
Upon agreement of the agency heads, the program will go to President Kennedy or—if it is in operation by that time—to the National Aeronautics and Space Council, which Vice President Johnson is expected to head.

The plan undoubtedly will require Congressional action. In addition there will be the need for funds. Committee members decline to make even "ballpark" estimates of the amount. However, some officials close to the committee believe it will require about $10 million in Fiscal Year 1962 and upwards of $100 million a year when it swings into complete operation, probably in FY '63.

NACCAM consists of the heads of the meteorological services of the three military services and the Federal Aviation Agency, Edgar M. Cortright of the National Aeronautics and Space Administration and Reichelderfer. The subcommittee, designated the Panel on Meteorological Satellites (POMS), is headed by Cortright. Dr. Morris Tepper, NASA chief of meteorological satellites, also sits on POMS.

• **Many-layered labyrinth**—Tepper told the Senate Space Committee recently that POM's is "charged with developing a specific technical and management plan for the development, implementation and operation of a national operational meteorological satellite system."

The NASA official pointed out that NACCAM and POMS represent only one of several routes by which interagency committees have jurisdiction over the weather satellite program. Scientific advice comes from the Committee on Meteorological Aspects of Satellites of the Space Science Board of the National Academy of Sciences.



ARTIST'S CONCEPTION of NASA's projected Aeros meteorological satellite, which is slated to carry a zoomar-type TV camera into a BD*-hour equatorial orbit.*

The research and development work, including interim operational use of the weather data, is coordinated on the working level through the Joint Meteorological Satellite Advisory Committee, which includes representatives of NASA, the Department of Defense, the three services and the Weather Bureau. At the policy level, coordination between the DOD and NASA is provided by the Unmanned Spacecraft Panel of the Aeronautics and Astronautics Coordinating Board.

Unless the Kennedy administration can find some way to cut through the labyrinth of committees, final approval of any program that emerges from the technical working group is likely to take several months.

It is expected that the operational satellite system will be based on the second-generation *Nimbus* satellite, which is scheduled for first flight in the latter half of 1962. However, some of the data-distributing techniques may be tested on *Tiros III*, to be launched during the hurricane season this summer, and *Tiros IV*, a recent addition to the program, scheduled for next winter.

• **Operational when?**—The first two *Nimbus* launches will be designed to prove out the spacecraft's basic design. The following two on the R&D program will be designed to test advanced instruments to be carried, such as radar for information on areas of precipitation, a radiation spectrometer for data on the atmosphere's temperature structure and a sferics detector to identify thunderstorm areas.

NASA is not saying at just what stage operational launchings might begin. However, a logical time might be immediately after the first two launchings—so that full operation might begin with the basic satellite while research continues on advanced components.

In a paper prepared before POMS began its deliberations, a group of Weather Bureau scientists, headed by

(continued on page 34)

Calculated risk . . .

Mace B Bases Readied on Okinawa

by Frank G. McGuire

NAHA, OKINAWA—Bases now are nearing completion for Air Force *Mace B* missiles with nuclear warheads, scheduled to become operational on this island during 1961.

The decision to base nuclear weapons on Okinawa—technically still Japanese soil—contained a calculated risk of major international political repercussions but these so far have not developed.

Although the U.S. occupies and completely controls the island, the government's official position is that the island is Japanese and will revert to that nation in time under our policy of residual sovereignty.

The nuclear-tipped *Mace B* missiles, scheduled for deployment in at least four sites on the island, have a 1200-mile plus range, bringing Communist Chinese industrial complexes within easy striking distance.

Fearful of repercussions in Japan, the U.S. deliberately has played down the bases. M/R received strong indication that responsible Japanese government officials aware of the program approve of it.

. Plans to deploy *Mace* to the island first were disclosed early in 1960 by Defense Secretary Thomas Gates and Gen. Nathan F. Twining, Chairman, Joint Chiefs of Staff, in testimony before the House appropriations subcommittee. Gates gave the operational date as December, 1961. Portions of the testimony were censored.

After that, a press release concerning the installations was prepared by the Department of Defense, M/R has learned. Following clearance through all security agencies concerned, the release was killed at the last minute due to fear of political repercussions.

Headquarters, Pacific Air Forces, and the U.S. High Commissioner on Okinawa still refuse to comment on the program.

The deployment will mark the first time the U.S. is known to have permanently based such weapons on Japanese soil. Previously, Japan's rejection of all nuclear weapons, even in its own arsenal (M/R, October 17, 1960, p. 39) was enough to keep U.S. nuclear arms out.

Until recently, American strategic planners have considered the Far East almost devoid of major targets for long range missiles with large-yield nuclear warheads. The buildup of industrial complexes in China is beginning to change this picture drastically.

With no strategic ballistic missiles in the Far East, and SAC strength reportedly limited to one B-47 wing on Guam, there is only limited U.S. nuclear strike force capability represented by tactical F-100D, F101A, A3D and other aircraft of the 5th and 13th Air Forces, and the Navy's 7th fleet.

There is no counterpart in Asia of the *Thor* in Britain, *Jupiter* in Italy and Turkey, *Polaris* on station, or the B-52 bases surrounding the USSR. Any long-range weapon such as B-52 or *Atlas* could reach the Far East, of course, but the Asian situation does not call for this heavy a weapon yet.

Military planners say the *Mace* requirement developed because there is no adequate substitute for having a sizeable heavy nuclear strike force 350 miles off the China coast.

Formosa does not fill the bill because we do not have complete control over it and its armed forces. The nuclear-armed tactical bomber wings scattered through Okinawa, Korea and the Philippines could easily use some beefing up and support, now that target size, dispersion and air defense have all increased in China.

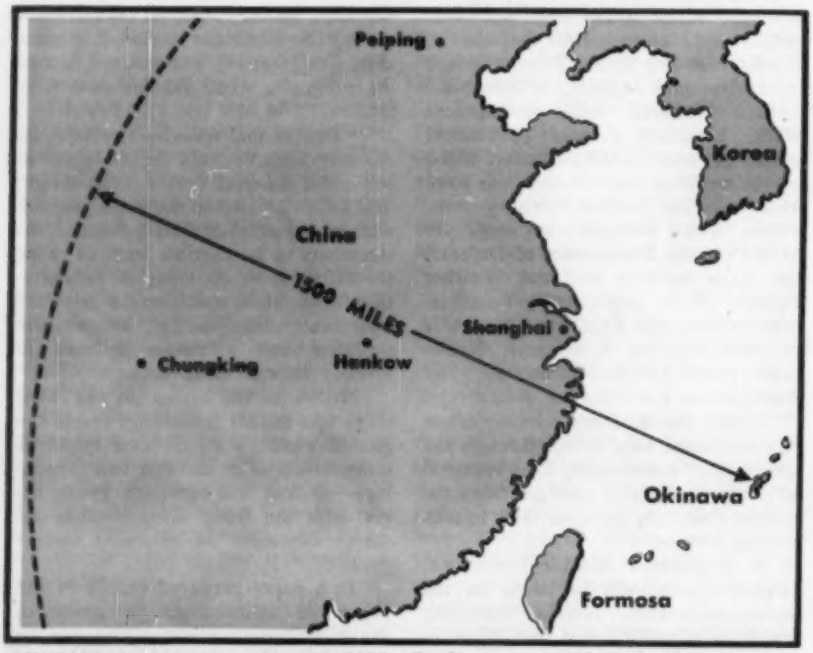
• **Birds should be ready**—The third flight test of a *Mace B* from a hard site at Cape Canaveral took place successfully in October, the flight test program began two years ago. Air Force says the vehicle's test program has been highly successful, and the Tactical Air Command began training with it in November.

By the time the sites on Okinawa are complete, *Mace B* should be ready for them.

Martin Co., prime contractor for *Mace B*, says the weapon's increased range over its predecessors, *Matador* and *Mace A*, is due to better utilization of internal space, thus allowing a greater fuel load.

Using all-inertial guidance, instead of the *Matador's* radar control system, *Mace B* does not need the assistance of a ground station such as that maintained in the Pescadores Islands for control of *Matadors* launched from Formosa.

Mace B has a ceiling of over 40,000 feet, a cruise speed of over 650 mph which becomes supersonic in its terminal dive on target, and a launch weight of 15,500 lbs. ⌗



OKINAWA-BASED Mace B's with 1200-mile-plus range could reach 850 miles into mainland, to Chungking or even Soviet Vladivostok. Thor would add 300 miles.

Goddard Trophy Goes To LMSD

Award will be a highlight of the National Missile/Space Conference; Webb to speak

WINNER OF the annual Dr. Robert H. Goddard Memorial Trophy for outstanding achievement in the missile/space field is the Lockheed Missiles and Space Division.

The award was made to LMSD for its work on the *Discoverer* and *Polaris* programs. Winner of the trophy is selected each year by the editorial staff of MISSILES AND ROCKETS magazine.

The trophy will be accepted by Herschel J. Brown, vice president and general manager of LMSD, as the highlight of the Goddard Memorial Dinner on March 16. The dinner is held as part of the National Missile/Space Conference sponsored by the National Rocket Club. More than 800 persons are expected to attend.

The trophy will be presented by William J. Coughlin, editor of MISSILES AND ROCKETS. Principal speaker at the dinner will be James E. Webb, making his first public address since taking office as administrator of the National Aeronautics and Space Administration.

Speakers at luncheon sessions of the March 14-17 conference will include Vice Adm. William F. Raborn, chief of the Navy's *Polaris* team, and Dr. John P. Hagen, director of NASA's Office of United Nations Space Conference.

• **First team recognition**—The annual Goddard Memorial Trophy is being awarded to an entire organization for the first time. Previous winners have been Wernher von Braun, S. K. Hoffman and K. J. Bossart.

The trophy is awarded each year for the outstanding accomplishment in the missile/space field during the previous year. Final selection was narrowed to two entries:

–Recovery of the first object from space with the successful retrieval of the *Discoverer XIII* capsule on Aug. 11, 1960.

–Achievement of operational status for *Polaris* with the sailing of the George Washington from Charleston, S.C., on Nov. 16, 1960.

With Lockheed Missiles and Space Division as prime contractor on both programs, the decision was made to award the trophy to LMSD for the teamwork and creative engineering which led to outstanding success in both.

• **Other awards**—Another presentation, to be made for the first time, will be the Nelson P. Jackson Memorial Aerospace Award, in memory of the president of the National Rocket Club, killed in an airplane crash last fall. Also to be presented are the Astronautics Engineer Achievement Award, the National Rocket Club Award and the Dr. Robert H. Goddard Memorial Scholarship Award.

The conference program includes panel discussions on military and civilian aspects of space flight and the missile/space market outlook. Those attending will be able to see the dedication of the Goddard Space Flight Center, a NASA installation in neighboring Greenbelt, Md., on March 16. A tour will be held March 17.

However, only 240 conference participants can be accommodated on the tour of the NASA Central Flight Control and Range Operations Laboratory, the Space Sciences and Applications Center and the Test and Evaluation Center. Reservations will be accepted on a first-come, first-served basis, the NRC said. ⌗

Government Contracting Needs Overhaul

AIA's Cook urges intense drive to cut rising costs; cites drop in earnings

GOVERNMENT-INDUSTRY contractural relationships may have been outmoded by technological progress and "need reappraisal and re-evaluation," says Gen. Orval Cook, president of Aerospace Industries Association.

Speaking before the American Legion National Commander's Conference last week, Cook called for a stepped-up effort in developing new techniques and procedures to combat continually upward spiraling of costs.

He cited recent success of Air Force contractors in cost-cutting programs that had already saved millions of dollars. Such savings, he said, may be the final answer to whether we can or cannot design and produce the weapons we need for survival. "This (cost reduction) must be an immediate goal of industry and government."

• **In a single decade**—To illustrate the tremendous technological changes that are taking place, Cook drew a vivid picture of our present missile/space posture as compared with that of only ten years ago.

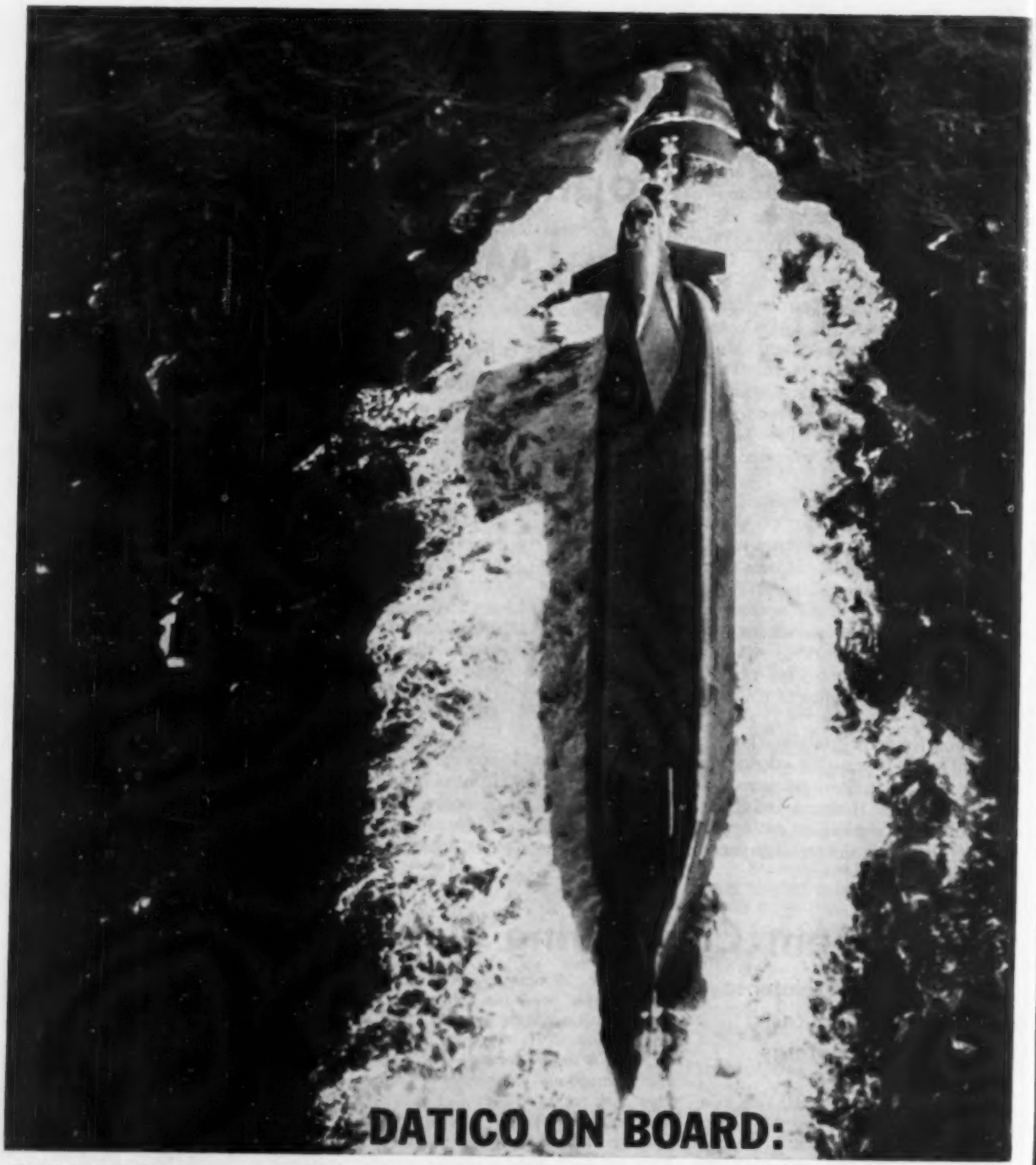
In 1950, we had not a single operational jet and the top speed of bombers was 300 miles an hour. The altitude record then was 47,000 feet.

Today, fighters operate at 1500 mph or more and surface-to-surface missiles reach speeds of 17,000 mph.

And the "aerospace" industry has changed nearly as radically, Cook said. In 1951, military aircraft orders totalled 92% of the backlog. Today, orders for missile/space vehicles make up more than 50% of the backlog and aircraft accounts for only about 30%.

Composition of the work force has also drastically changed in this decade. Nearly 200,000 more people are employed by the "aerospace" industry today, but only one-fifth of these are production workers. On the other hand, engineering employees—scientists, engineers, technicians—have increased to where, in one typical company, they make up one-third of the total employees.

Cook pointed out that the industry has had to invest over $1 billion in new facilities during the past five years. This, along with higher wages, inflation, and the impact of renegotiation and other Government fiscal practices, has severely limited the earning capacity of the "aerospace" industry. Present earnings are less than in 1950, even though sales are five times as great. ⌗



DATICO ON BOARD:

SIX MONTHS FROM CONTRACT TO COUNTDOWN

Just six months following contract award, Northrop began deliveries of Datico automatic checkout equipment for use in the Navy's Polaris Fleet Ballistic Missile program. Datico is used in factory, depot, tender, and submarine operations.

Datico is a digital automatic tape checkout system with a wide variety of applications. Its successful integration by Northrop into the Polaris and other major weapons systems demonstrates that the same basic Datico equipment can be used at all levels of maintenance and operation, utilizing the same test standards and methods and operated by personnel with the same basic training.

Northrop is at work on more advanced versions of Datico to extend its capability to an even wider range of military and industrial systems.

NORTRONICS
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Technical Countdown

ASTRONAUTICS

No Lunar Orbit Try Before 1965

The next lunar orbit attempt will be in 1965, according to the present NASA schedule. It will be an outgrowth of Project *Surveyor*, aimed at soft-landing a *Centaur*-launched spacecraft on the lunar surface, beginning in 1963.

Prospector to be Lunar Workhorse

The *Prospector* spacecraft, designed for roving about the moon's surface after making *Saturn*-boosted soft landings beginning in 1965-66, is expected to remain in service after manned lunar landings begin, now scheduled for 1971. Edwin M. Cortright, NASA chief of lunar and planetary programs, says *Prospector* can serve the lunar explorers for personnel transportation and to carry emergency supplies. Another version of *Prospector*, designed to return lunar samples to earth before men arrive, will be a "carrier pigeon" for the explorers to use in making return shipments.

Solar Pressure Varies Echo Orbit

Solar pressure pushed the perigee of the *Echo I* balloon satellite down to 600 miles by Jan. 1, from its original altitude of 945 miles. Now that the earth is on the other side of the sun where it was at launching last Aug. 12, the sun is pushing the orbit back toward where it started. The cycle is expected to be repeated until atmospheric drag has shrunk the orbit to the point where the sun cannot push it back far enough. The satellite has at least another year of life, and probably more.

Space Flights Timetabled by Computer

Lockheed is programing an IBM 7090 computer to figure timetables for space flights for years to come with use of low-thrust ion and plasma propulsion systems. Work is under Wright Air Development Division contract.

Super Scout Launch in 1962

The first *Super Scout* will be *Scout 11*, the third operational vehicle, to be launched in mid-1962. The next *Scout*—No. 5—will be checked out at the Chance Vought plant under CV's new prime contract, eliminating time-consuming checkout at Wallops Island.

ADVANCED MATERIALS

Wrong Emphasis in Filament Winding?

Better binding resins for high-temperature applications in filament-wound case are being ignored in the search for superior fibers. Current Air Force feeling is that the resins, rather than other variables, will soon be the limiting factor. This is already becoming true in certain areas.

Windows Make Problems

An effort is being made to bring airframe designers and glass manufacturers together on windshield problems in high-speed vehicles. The B-70 and *Dyna-Soar* applications cannot be met with current techniques—where the designer merely leaves a hole for the glazier to fill. Air Force presently has one jet aircraft in operation which requires glass replacement every ten flight-hours.

PROPULSION

Saturn Geyser Capped

One of the problems discovered during final series of *Saturn* static tests was that propellant coming through interconnecting pipes at the bottom of the tanks flared up in a fountain and wasn't picked up by the pumps. Problem was solved by putting a "hat" on the tank inlet.

Neosho LOX Plant in Operation

Linde's new LOX plant at Neosho, Mo., adjacent to the Rocketdyne engine production plant, is now on stream. Capacity is 140 tons per day.

New Second Stage Adds to Polaris Range

Most of the 300-mile range increase of *Polaris A-2* is credited to the new Hercules second-stage motor with its lighter Spiralloy case and higher I_{sp} propellant. The case is constructed of nearly 268 thousand miles of continuous glass filament—enough to reach from earth to the moon.

SUPPORT EQUIPMENT

Gearless Drive for Advent Shipborne Antennas

Navy has specified gearless power drives for 3-axis tracking antennas to be used on shipborne terminal for *Advent* communications satellite system. General Electric Ordnance Dept.—which developed the gearless drive for *Tartar* fire control radar—has been awarded the contract.

Radio Telescope to Use Servo-Optical Alinement

The Navy has decided to use a servo-optical system to aline the NRL 600-ft. Sugar Grove radio telescope. Both optical and inertial systems were originally considered. Contract for the system is expected to be let soon.

No. 4 Saturn to Use Second Complex

Launch Complex 37 at Cape Canaveral, the second *Saturn* complex, is to be used beginning with the fourth *Saturn*, currently scheduled for launch in early 1963. This second facility has been funded, but construction has not yet started.

ELECTRONICS

World's Fastest Germanium Switching Transistor

Sylvania has produced a new germanium epitaxial mesa transistor with a maximum switching time of only 110 nanoseconds (10^{-9} seconds)—over twice as fast as conventional switching transistors. New device combines the advantages of both epitaxial and mesa construction.

Transistor Sales Set Record

1960 transistor sales zoomed to a total of nearly 128 million units—a better than 50% increase over the previous year—according to Electronic Industries Association figures. Dollar value was over $301 million.

Arma Leads Guidance Producers

Based on recent industry reports to M/R, the 1960 production market for missile/space inertial-guidance systems was led by American Bosch Arma (22%), followed by AC Spark Plug (19%), Autonetics (12%), Sperry Rand (10%), and General Electric (9%). Honeywell, Bendix, Nortronics, Kearfott, and Summers Gyroscope controlled about 5-6% each. By 1962, however, leaders are expected to be Autonetics, Bendix, GE, Honeywell, and Summers—in that order.

space medicine

Endless Recycling Of Water & Oxygen

System weighing 200 lbs. could sustain space flyer indefinitely; GE gets additional contract

by Heather M. David

PHILADELPHIA—Astronauts on long-term voyages may get all their water and oxygen supply from a new life support system weighing as little as 200 pounds.

The system, under development at the General Electric Space Sciences Laboratory here, requires only one day's supply of oxygen and water which is recycled endlessly from man's metabolic wastes. As a yardstick, the Project *Mercury* oxygen and water supply and air purification system—which uses stored materials—weighs almost 90 pounds.

• **First in use**—One part of the system, the water recycling unit, will go into operation at the Naval Air Materiel Center within the next four or five months. It will be used in bioastronautics research and in duplicating mission profiles at the Air Crew Equipment laboratory. Facilities of this laboratory are used by all the armed services and NASA.

Under an $18,000 Navy contract just awarded GE, the unit will provide potable water for six men for periods of eight to fourteen days from their recycled digestive wastes.

The GE Space Sciences group, headed by Biotechnology manager Jack J. Konikoff, has been researching closed systems since late 1958. Part of the work on the urine recycling system has been supported by a two year $94,000 NASA contract awarded last February.

Last fall, the director of the Naval Air Crew Equipment Laboratory, Capt. Roland A. Bosee, was the subject of a six day test of the system. For the thousandth time, Jack Konikoff says, "Yes, he's still alive."

As a matter of fact, very extensive blood analysis, including red and white cell count, and other physical data bore out the fact that there are no ill effects from the reuse of water.

In addition to the successful tests on man, a colony of rats has been maintained on recycled metabolic wastes for three generations. There has been no evidence of toxic buildup or genetic effect.

Visitors to the Space Sciences Laboratory are invited to take a taste comparison test. They're offered three glasses of water, asked to pick the one which tastes worst. The glasses contain distilled water, recycled water and "Brand X." Almost invariably picked as the only one with a foul taste, Brand X is revealed to be Philadelphia water.

Microscopic and chemical studies of the reprocessed water support this. Water recovered in the General Electric system has been carefully measured by U.S. Public Health Service Drinking Water Standards, and adjudged potable. It scores well against impurities counts of ordinary tap water and is as free from taste or odor as distilled water.

• **Two-step process**—The process by which water is recycled is relatively simple. The waste material is collected in a still pot and heated in a vacuum of about 60 mm Hg, or 1.16 psi. At this low pressure, it will vaporize at temperatures of about 90°F. Non-volatile materials are left behind.

However, vacuum distillation alone will not purify the water. Ammonia and other volatile materials still remain.

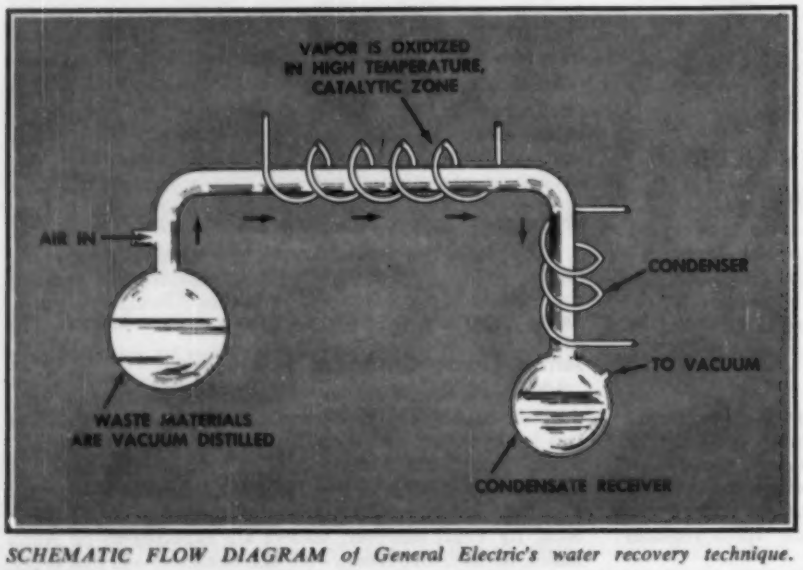
Konikoff's group has found that by oxidizing the vapor in the presence of a catalyst, these materials can be destroyed. Thus the vapor is passed through a high temperature zone in which a minute amount of platinum gauze is contained. This gauze is not contaminated by the reaction and apparently can be used indefinitely.

The vapor is then condensed and ready to be used for drinking purposes.

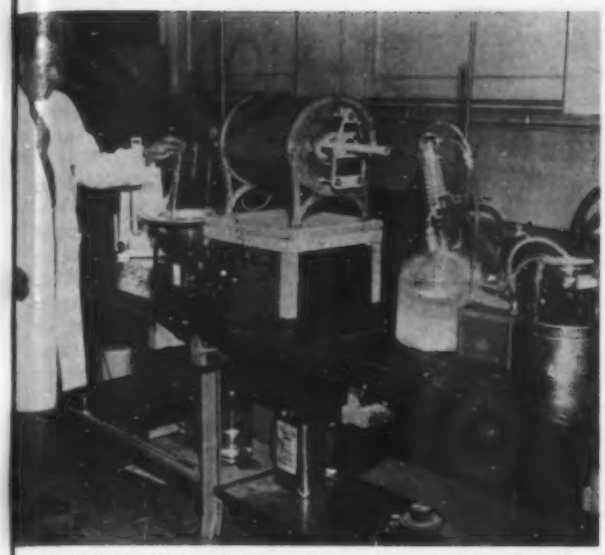
One modification will have to be made in the system to adapt it for weightlessness. Konikoff sees several solutions: the liquid may be held by sponge material, or a microscopic filter could be used to separate the liquid from the vapor. The liquid molecules, being larger than those of the vapor, would be held under the filter.

Use of the system in space will bring benefits, too. The space vacuum is available for the vacuum distillation process. It also is feasible that a solar furnace could be constructed to center on the catalyst in the high temperature zone. This would cut the unit weight to as low as 30 pounds. The zone requires temperatures to 950°F.

No extra air needs to be pumped into the system but that normally cir-



SCHEMATIC FLOW DIAGRAM of General Electric's water recovery technique.



LABORATORY TESTS have proven concept. Left: Capt. R. A. Bosee checks water recycling unit of type GE will develop for Naval Air Crew Equipment Lab. Right: CO_2 decomposition studied by J. J. Konikoff, A. H. Okamoto, V. Cordua.

culating in the cabin. Apparently only minute amounts of air are required for oxidation to take place, a blessing since the greater the air requirement, the higher the heat input.

Germs and viruses probably would not survive after exposure to the high temperatures. Laboratory samples showed almost negative amounts of bacteria and strep organisms, even though the equipment itself had not been sterilized. City water suffered by comparison.

A normal, active man consumes about five pounds of water a day. He expends about one-half of this digestively, the other through respiration and perspiration.

Water given off in respiration and perspiration can be retrieved from the cabin air in several ways. The GE group says the best seems to be by collection by lithium chloride desiccant, which is heated to about 300°F and the water driven off. The material is reusable.

The water also can be collected by dew-point condensation or freezing. These methods may have advantages since a closed cabin will require some type of heat exchanger to run a cooling system to cool the cabin atmosphere. The air moisture could condense upon the exchanger, or if the wall temperature were low enough, freeze there. This water could be collected and made available for drinking.

The second major system in the General Electric concept is the recycling of oxygen from carbon dioxide.

• **Removal of CO_2**—In the Project *Mercury* system, lithium hydroxide is used to remove carbon dioxide from the air. For short voyages, this material is very efficient since it will absorb almost its own weight in carbon. However, for a longer voyage, this material is impractical since it is very difficult to make it reusable.

The Advanced Engineering Group in MSVD's Life Support Operations, responsible for life support hardware and engineering, have worked out a "molecular sieve" to collect carbon dioxide. Although not as efficient in a weight-work ratio as lithium hydroxide, it can be reused after a simple regeneration process.

According to Norman Belasco, senior project engineer, the material used is a synthetic zeolite crystalline structure. The tiny white crystals are contained in cartridge form, probably two of which would be carried on a trip.

A molecular sieve is a sieve in the sense that it has minute orifices through which only molecules of a certain size can pass. The zeolite was chosen to select the carbon dioxide from the circulating air and hold it in the cavities of the crystal framework.

When one cartridge becomes "saturated," it is cut off and exposed to a vacuum at 212°F. The CO_2 is removed, caught and collected for the oxygen recovery system. The presence of the space vacuum will cut down the regenerating time to minutes, but for laboratory purposes the cartridge is reusable in about a half-hour.

• **Oxygen recycling**—The General Electric group utilizes a physico-chemical reaction to recover oxygen from the carbon dioxide. The technique is called the Fischer-Tropsch Synthesis.

All the oxygen is removed from

TABLE I

Equipment weight per man for several ecological systems

TYPE SYSTEM	STORED SUPPLIES	FIXED APPARATUS WEIGHT*	WEIGHT FOR ONE DAY	WEIGHT FOR 30 DAYS
Open system, all stored supplies	16 lbs.	5 lbs.	21 lbs.	485 lbs. (will multiply by number in crew)
Partially closed system: water in air is regenerated	12	22	34	382 (will multiply by number in crew)
Partially closed systems: Both water and carbon dioxide in air regenerated	9	37	46	307 (increases with each succeeding crew member)
GE closed system	1 (food)	199	200	229 (increases but does not multiply with each succeeding crew member)

* Includes 5 lbs. activated charcoal which removes odors and air contaminants

TABLE II

Weight and Energy Requirements for General Electric Closed System

SUBSYSTEM	ENERGY REQUIREMENT PER DAY—BTU	APPROX. WEIGHT OF APPARATUS
Water retrieval from urine	7000	30.00 lbs.
Water retrieval from air (LiCl adsorbed)	5270	9.28
CO_2 removal from air (molecular sieve)	2190	10.00
Oxygen retrieval from CO_2	—3280 (exothermic)	45.00
Water from CO_2	18,400	5.00
Oxygen from water		
Energy supply—fuel cells, weight and storage		100.00
TOTALS	29.580 Btu (approx. 9 Kwh)	199.28 lbs.

the carbon dioxide and converted into water by this reaction:

$$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$$

Optimum temperature for the reaction seems to be between 750°F to 875°F, Konikoff said.

As the equation shows, methane is formed as a biproduct. There is a possibility this could be utilized as a fuel, or as a basic starting material for a wide variety of chemical syntheses.

The Space Sciences group is working on the idea that the methane could be decomposed into carbon and hydrogen. Theoretically, the carbon can be activated and used for odor control. But this process will not be simple.

Oxygen is recovered by electrolysis from the water formed by the reaction. The hydrogen also given off is recycled through the reaction chamber to participate in the initial reaction for the next batch. General Electric has developed a special fuel cell supporting this entire process which weighs only five pounds.

The only other element needed in the life support system is food. Konikoff said there is no immediate need for working out an algae recycling system as has often been suggested. Not only is the stuff pretty unpalatable but the present state of the art in packaging and dehydrating conventional foods makes it possible to carry a year's supply weighing less than 400 lbs.

• **Future projects**—General Electric's Space Sciences Laboratory also is engaged in algae research. Although algae are an effective source of oxygen, they require such optimum growing conditions (light) and are needed in such quantity that they are generally considered impractical for space trips in the near future. Konikoff's group is searching for other practical uses of the plants.

Possibilities they are considering include the side use of algae as a radiation shield, and as a source of chemicals which could be converted into fuels and other useful compounds. ⌗

NASA Maps Post-Mercury Manned Shots

Two or three years between close of Mercury and start of Apollo are planned for

SPACE FLIGHT with men and animals after the end of the presently approved Project *Mercury* launching is up for decision in the near future.

The National Aeronautics and Space Administration has contracts with McDonnell Aircraft Corp. for the delivery of 24 *Mercury* capsules, of which six have been flown and the remainder are to be flown by the end of 1962 or early 1963.

The schedule for Project *Apollo*, the follow-on program aimed at launching three-man capsules aboard *Saturn* vehicles, is still uncertain. But it is clear that manned *Apollo* flights could not begin before *Saturn* is man-rated, probably in 1965 or 1966. Thus there is a period of two or three years between the end of the present program of manned *Mercury* flights, and the deginning of manned *Apollo* flights.

Plans under consideration include orbital flights with animals and then men in capsules something like the *Mercury* capsule for periods ranging from 2 to 14 days. Clark T. Randt, director of NASA's Office of Life Science Programs, told the Senate Space Committee recently of plans to investigate the ability of living organisms to cope with the space environment in five areas. He listed them as:

–Effect of weightlessness on the performance of men and animals.

–Measurement of the electrical phenomena associated with brain activity.

–Observation of the reaction of the heart and circulatory systems.

–Physical science experiments in radiation and micrometeorite impact.

Randt said the current *Mercury* program and related experiments will fill the need for the required data for periods up to several hours. The next phase of investigation, he said, is to obtain similar information for periods of two days to two weeks.

Other NASA sources indicated that it is not clear whether an *Atlas* booster is capable of putting a *Mercury* capsule into stable orbit lasting longer than the 4½-hour period planned for the first phase of *Mercury* flights. The first capsule orbital flights are expected to provide such data.

If *Atlas* alone cannot do the job, NASA might consider man-rating the *Agena* or *Centaur* stages for follow-on manned experiments, one source said.

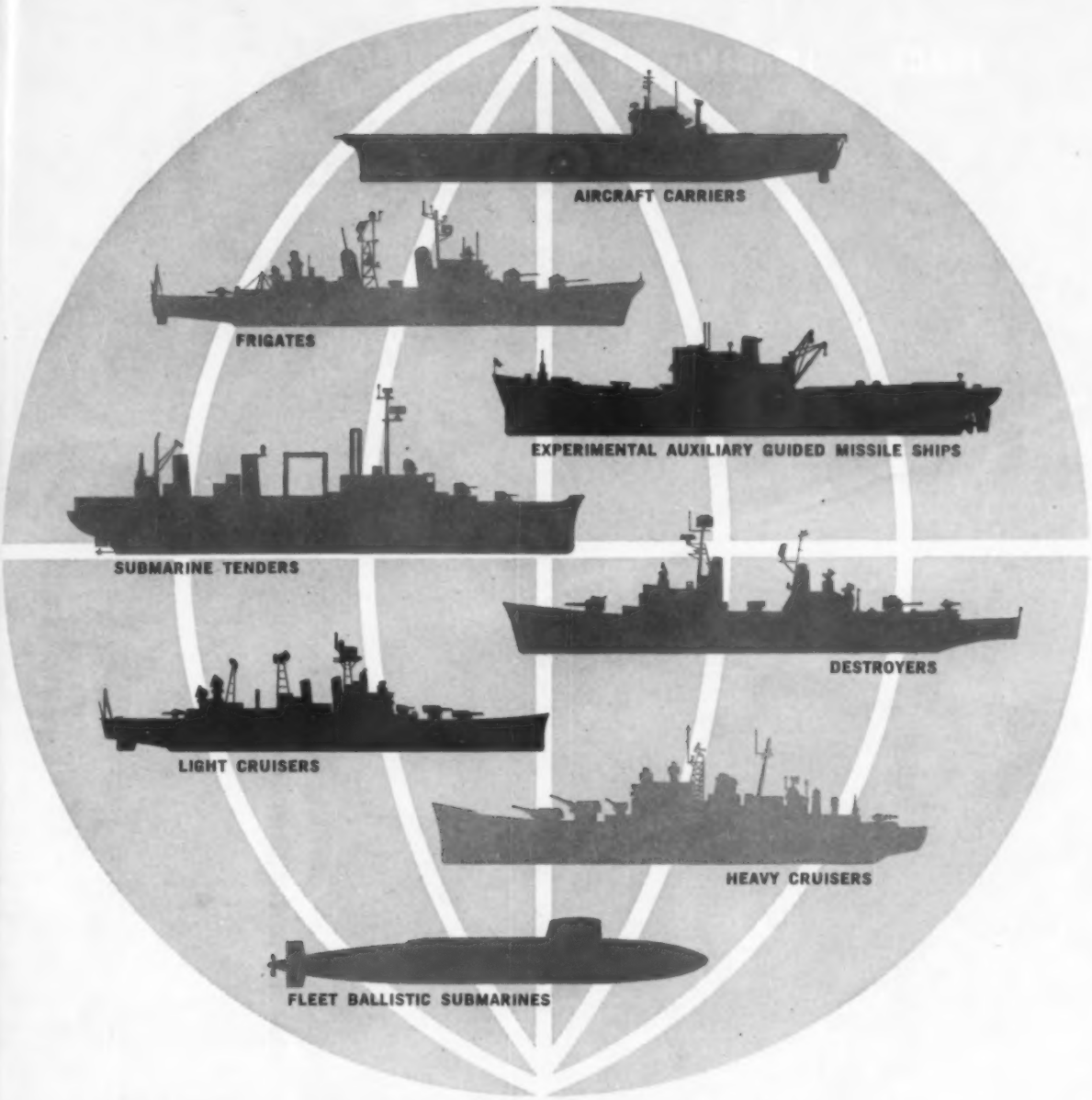
The present *Mercury* program calls for launching 18 more capsules. One will be aboard a *Little Joe* and five will be in the *Mercury Redstone* program. Unless there are switches made necessary by repeating *Little Joe* or *Redstone* flights, the remaining 12 would be *Atlas* capsules. Thus, if manned orbital flights begin with *Mercury Atlas 8* or sooner, each of the seven astronauts might have the opportunity for one orbital flight. ⌗

RCA Building Advanced Vehicle Testing Center

A MULTIMILLION-DOLLAR advanced space vehicle test center will be put into operation at Princeton, N.J., by the Radio Corporation of America.

The installation, adjoining present engineering laboratories of the RCA Space Center, will center about an eight-story-high structure housing a vacuum chamber for complete satellites and space vehicles.

In addition to a vacuum comparable to that existing several hundred miles above the earth, the chamber will have a temperature range from –100° to 250°F. The system will maintain these conditions for up to three months. ⌗



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Within these labyrinthed entrances, shielded from the world by six feet of reinforced concrete and full-height earth barricades, lurks the mighty Betatron. Its task: to search out any defect in production-line propellant grains exposed to its powerful X-ray eye.

This giant eye is only one part of our complete nondestructive test installation at Bacchus. Through such steps, the life history of each individual unit becomes an open book—its reliability can be computed, its readiness known before the need arises. Such exacting tests pave the way to space.

Here twenty-five million electron volts probe the inmost secrets of a missile

Vastly more powerful than any known industrial X-ray apparatus, the Betatron yields a clear picture through the full girth of the third-stage Minuteman engine in an eight-minute exposure, contrasted with more than a nine-hour exposure required with 1,000 curies of cobalt 60. Resolution is such that irregularities down to 0.01 inch can be examined. Power of the instrument, and dimensioning of the building which houses it, are more than equal to the task of scrutinizing interior topography of the cast composite double-base solid-propellant motors made at Bacchus: the third-stage Minuteman, advanced second-stage Polaris, Altair, and the others.

XP61-1

Chemical Propulsion Division

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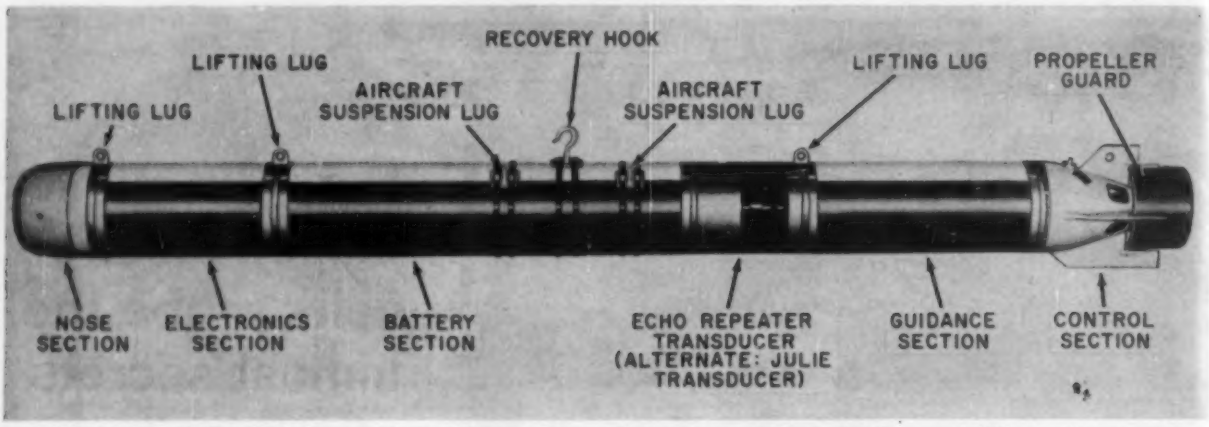
Navy Getting Sub Target Simulators



SUBMARINE SIMULATOR for training ASW crews in art of detecting, localizing, classifying and killing underseas craft.

by William Beller

SMALL TORPEDO-LIKE devices able to maneuver and sound like submarines will soon be exercising the Navy's antisubmarine warfare teams. First production units of these submarine target simulators are being delivered to the fleet this month.

This means that the Navy can start putting back into line duty some of the submarines it has been using as practice targets. It also means that the service can train ASW technicians such as sonar operators under realistic conditions but without the high operating costs of a submarine.

The simulators going into operation are the first to be self-propelled and able to analog all the functions of a submarine. They can maneuver evasively, give out submarine running noises such as propeller beat and machinery operation, and echo sonar pulses.

The target simulator can be launched and recovered from surface ships and helicopters. With a modification, it can be launched out of a submarine's torpedo tube.

When submarines are in short supply for training ASW teams, or when the instruction is for technicians and elementary, then land-based simulators or sea-based echo-repeater targets are often used. However, because these devices are several degrees away from those used under real-life situations, they are not entirely satisfactory. For this reason, the U.S. Navy Training Device Center contracted with the Clevite Ordnance Div. of Clevite Corp. to develop and build the ASW target now in production.

• **How it works**—Clevite made the target simulator on the modular principle. This makes it possible to change one or more of the device's functions by simply replacing one subassembly with another. Thus, the simulator can be turned into an ASW countermeasure or fitted with a homing head or transformed into a torpedo target.

The simulator is able to perform typical submarine maneuvers for two hours. Under special conditions, this period can be extended to six hours. The vehicle will cruise at 8 knots and can show bursts of speed up to 10 knots.

Its primary power comes from a rechargeable battery. This drives a fractional horsepower motor which turns a set of contra-rotating propellers. The target is steered by elevators and rudders which are solenoid-controlled.

When the simulator passes through a sonar beam, it receives, amplifies and retransmits the sonar pulses exactly the way an actual submarine would. At the same time, the target generates and transmits the noise characteristics of a running submarine.

After its run is finished, the target surfaces and aids in its recovery by ejecting dye from a 1.5-quart reservoir. Also, its echo-repeater sends out a signal to permit location by sonar.

• **Putting in the performance**—The simulator target contains a programer for prescribing in-water operations. It controls propulsion and guidance. A moving 35mm film tape passes between a rotary platen and five contact fingers. Slots punched in the tape permit one

Characteristics of ASW Submarine Target

Length	**132 in.**
Diameter	
Body	**10 in.**
Across Stabilizing Fins	**13⅛ in.**
Weight	**344 lbs.**
Buoyancy	
Salt Water	**13 lbs. positive**
Fresh Water	**3 lbs. positive**
Primary Power Supply	**Battery**
Speed	**8 knots**
Running Time	**2 hr. max.**
Arming Time	**30 sec. min.**
Depth	
Up Limit (Adjustable)	**50 ft. min.**
Down Limit (Adjustable)	**200 ft. max.**
Initial Operating Depth	**Equal to either up or down limit**
Rate of Depth Change	**4.6 ft. per sec.**
Initial Course Preset	**Either Port or Starboard, 0° –180°**
Azimuth Turning Rate	**5° per sec.**
Sonic Simulator	
Range	**5000 yd.**
Frequency	**100 cycles to 10 kc. per sec.**
Echo Repeater	
Frequency	**8-30 kc. per sec.**
Julie	
Frequency	**3-7 kc. per sec.**
Sonic End-of-Run Indicator	
Frequency	**8, 10, 12 or 14 kc. per sec.**
Dye Capacity	**1.5 qt.**

or more contact fingers to become grounded for a short period.

The grounding of a contact finger actuates a corresponding relay to operate one of five functions: speed change, port turn, starboard turn, shallow stratum and deep stratum. At the end of a run, the programer actuates a relay to bring the target to the surface.

Slots may be punched in the programer tape to send the target on maneuvers that might be used by a submarine trying to evade detection. The slots may provide for a straight run or a circular course, or for numerous changes in depth or azimuth during the course of a run.

Two standard tapes are used, one pre-cut for echo-repeater operation and the other for Julie-type operation. Other type tapes can also be cut and used.

The echo repeater is a passive device which functions upon receiving a pulse from a sonar transmitter. The pulse is amplified and retransmitted back to the sonar receiver with enough power to simulate the echo to be expected from a real submarine.

The Julie system is also a passive device, which functions upon receiving the noise signals created by an underwater explosion. The noise is amplified and transmitted to provide echoes to a sonobuoy receiver. In turn, the sonobuoy receiver transmits the noise by a radio link to either ship or aircraft.

The target's sonic simulator continuously generates noise characteristic of submarine cavitation and screwbeat. There is reasonable matching of these characteristic noises to those produced by submarines traveling 6 to 12 knots. Search ships having sonar equipment operating in the frequency band of 100 cycles to 10 kc. can track these noises up to nearly three miles range.

Because of the economies that can come from using submarine simulator targets instead of submarines for training ASW teams, many of the NATO countries are showing high interest in the scheme. In addition, the Royal Canadian Navy has been directly participating with the U.S. Navy in the recent evaluation tests of the Clevite-designed vehicle. ⌗

Clevite's Rugged 'Oyster' Gives Consistent Performance

PRODUCTION QUANTITIES of a new general-purpose underwater transducer are showing unusually consistent response curves. This is of high interest to the sonobuoy industry which often has to cull quantities of production transducers to find those in a given performance bracket.

The device, which came on the market recently, is rugged enough to be planted by aircraft, cheap enough to be highly expendable, and resistant enough to withstand deep salt-water immersion for one week.

Designated the "Clevite Oyster," it is manufactured by the Clevite Ordnance Div. of Clevite Corp. In production quantities, each transducer is sold for about six dollars.

• **Design and performance**—The usual transducer has a sensitivity range —the ratio of output voltage to applied voltage—of over 10 db. The Oyster is reported to have a sensitivity range of only 2 db. Hence, special circuitry does not have to be included in a sonobuoy to make up for variations in the transducer's performance.

A line array of Oysters dropped from aircraft can have their sensitivities arranged so that signatures of different types of underseas craft can be recognized.

The Oyster design comprises two stiff circular pistons which drive a pile-up of hollow discs of piezoelectric material. As these discs are compressed, they produce sound waves. The simple, straightforward and axial, design makes the device strong and relatively insensitive to shock, vibration and heat.

PRODUCTION version of the Clevite Oyster for use in sub detecting.

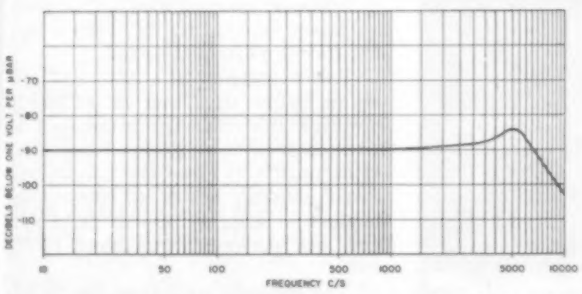
The piezoelectric material, a ceramic, is prestressed in compression. This prestress plus that put in during operations by water pressure gives the material no chance to take on a tensile load, which would shorten its operating life.

Over its normal frequency range, the transducer is substantially nondirectional. In the medium and low frequency ranges, it can be used as a low power transmitter, with an efficiency at resonance of about 15%.

The Oyster has survived the following environmental tests: shock, 150g; thermal shock, 150°F to 40°F; storage temperature, 160°F to −60°F; salt-water immersion, one week; test pressure, 60 psi; and sunshine, 100 watts/sq. ft. for 60 hours. ⌗

Specifications

Diameter: 2 in., Thickness: ½ in.
Weight, without cable:
Brass pistons 3.7 oz.
Aluminum pistons 1.6 oz.
Operating frequency: 10-10,000 cps.
First hydrophone resonance: 5 kc.
Capacitance: 2900 picofarads.
Output voltage below resonance:
—90 db., ref 1 v. per microbar (into 60 ft. of cable).
Dynamic range in excess of 100 db.
Transmitting efficiency (resonance): 15%



TYPICAL RESPONSE curve for Oyster at end of 60-ft. cable.

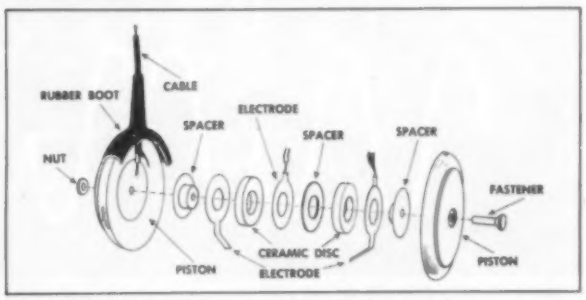
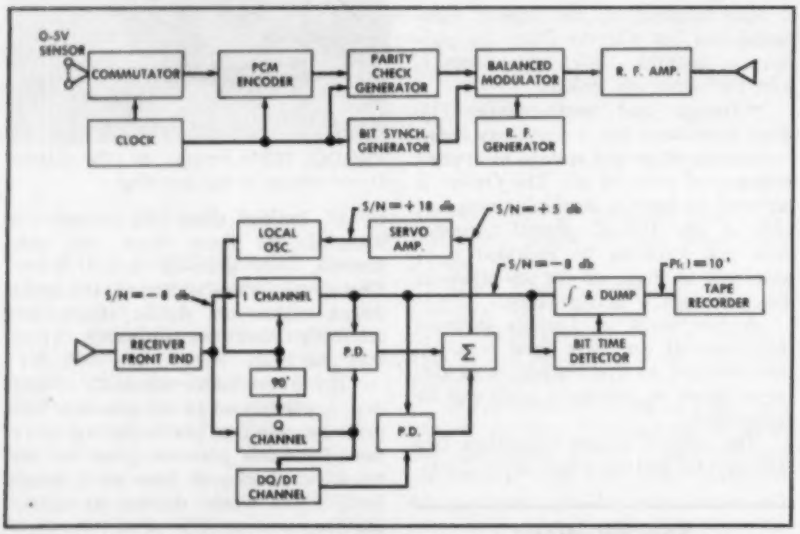


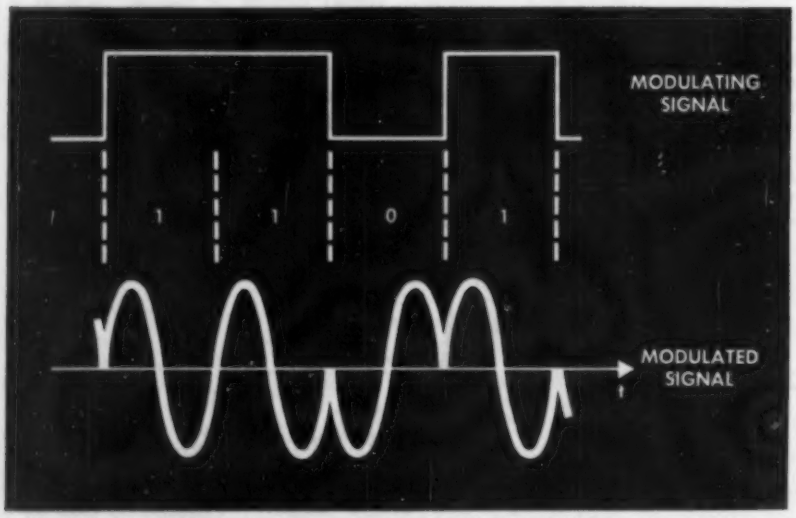
DIAGRAM of underwater piezoelectric transducer.

GE's 'Synchrolink' Swells Telemetry Range

Makers claim PCM-PS system will send signals three times farther with same power as present systems



PCM-PS BLOCK DIAGRAM. Product detectors (P.D.) following standard receiver front end avoid penalty of picking up r-f detection threshold at low S/N levels.



CONTINUOUS LEVEL of r-f energy is transmitted with PCM-PS system. "O" signal is 180° out of phase with that of "1."

AN EXPERIMENTAL version of a new digital telemetering system with tremendously increased range capability has been built by General Electric Missile and Space Vehicle Department.

GE says the new "Synchrolink" PCM-PS (for pulse code modulation, phase-shift) system can transmit signals three times as far as any equipment yet flown, or transmits data over the same distances with only about one-tenth the power requirement of present systems.

The increase in range capability is based on "inherent efficiencies" of the Synchrolink system which make it, according to Dr. Stanley Hurst, GE scientist, "the most efficient practically realizable with today's technical know-how."

Efficiency gains are based primarily on the use of correlation detection and a novel redundancy coding method. Use of a threshold-free synchronous receiver permits r-f detection of signals at extremely low signal-to-noise ratios (less than −8 db).

Other advantages claimed for the Synchrolink system:

–Existing ground equipment requires only minor modification to receive Synchrolink signals.

–Transistors are used as switches—their most reliable mode.

–The system is flexible, allowing for alterations of channels and combinations of channels, even in flight, to accommodate measurement changes.

–Digital techniques are inherently of high accuracy. Data may be repeatedly converted, transmitted, or stored for long periods with no loss in accuracy.

The PCM-PS system employs double sideband suppressed carrier modulation of the r-f carrier. Equal amounts of r-f energy are transmitted at all times with the "O" signal 180° out of phase with that of the "1".

Compared with other systems, the PCM-PS requires a transmitter power equal to or less than that of an ideal PCM-FM system. In practical missile/space applications, limitations due to r-f detection threshold and doppler shift problems further reduce the efficiency of PCM-FM (and PCM-PM) below theoretical values.

• **Power compensation**—The average power required for PCM-PS is half that for the PCM-AM system.

Power efficiency of a PPM-AM system is better than that of PCM-PS. However, this efficiency is obtained at the expense of much greater bandwidth. At identical S/N ratios and bandwidths —and assuming use of an efficient redundant code for PCM—all PCM systems can perform better than PPM-AM.

The airborne portion of the PCM-PS telemetry system consists of a com-

System	Relative Power Efficiency	
	S/N Out = 44 db	S/N Out = 32 db
PPM—AM	1	1
PCM—PS	1.75	1.25
PCM—FM	1.75	1.25
PCM—PM	2.2	1.6
PCM—AM	3.5	2.5

mutator, PCM encoder (analog-digital converter), parity encoder and r-f section with a balanced modulator for PS modulation. Frame synchronization is maintained by transmitting a unique code at the beginning of each frame. Bit synchronization uses a signal added to the PCM pulses at about 1% of full radiated power.

The receiver has a standard front end, followed by a pair of product detectors and the acquisition and tracking loops for the reinserted carrier frequency. The dipolar pulses with fluctuation noise are processed in the integrate-and-dump decoder. Beginning and end of a bit period are derived from the bit synchronization signal and are used to start and stop the integration process.

The output pulses of the integrate-and-dump equipment are free of noise but have a definite error rate. Error correction through the use of the parity information will be done during the data processing, either in the digital computer, or in an auxiliary equipment. ‡

Top Panel Prepares Weapons Testing Data

DR. J. B. FISK, president of Bell Telephone Laboratories, is head of a panel to study, review and bring up to date for the new administration the technical considerations bearing on ending weapons tests.

The panel will make data ready for the resumption of negotiations with the Soviet Union at Geneva, now scheduled for March 21. Other members of the Fisk panel are:

Dr. Hans A. Bethe, Cornell University; Gen. Austin W. Betts, Atomic Energy Commission; Dr. Harold Brown, Lawrence Radiation Laboratory; Spurgeon M. Keeny, Jr., White House Science Adviser's Office; Dr. Richard Latter, Rand Corp.; Gen. Herbert B. Loper, Office of Secretary of Defense; Dr. J. Carson Mark, Los Alamos Scientific Laboratories; Doyle Northrup, Air Force Technical Application Center; Dr. Wolfgang K. H. Panofsky, Stanford University; Dr. Frank Press, Cal Tech; Gen. Alfred D. Starbird, AEC; Dr. Herbert F. York, DOD. ‡

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SINGLE AND 2 AXIS ACCELEROMETERS

Highly precise and accurate, Kearfott's accelerometers are pendulous devices which sense airframe acceleration forces acting on them.

A pendulum utilizing a unique Hooke's joint suspension displaces as a function of acceleration. An AC pickoff signal is rectified and applied to voice coils restoring the pendulum to null. The DC required for restoration is proportional to acceleration. Typical characteristics for these units include range of ±25 g's, scale factor of 5.0 ma/g, linearity of ±0.005% and threshold of 2 x 10^{-7} g's.

CHARACTERISTICS:	SINGLE AXIS	SINGLE AXIS	TWO AXIS
TYPE NO.	F2401	429037	326778-1
Range of Measurement	±20g	±25g	See above
Scale Factor (output)	5.0000 ma/g	5.0000 ma/g	
Operating Temperature	155°F ±5°F*	50°F and +160°F	
Threshold	5 x 10^{-7}g	Less than 2 x 10^{-7}g	
Zero Stability	±0.05 milliradian	±.00005g day to day	
Vibration	Up to ±10g peak from 20 to 2000 cps	Up to ±5g peak from 20 to 2000 cps	
Storage Temp.	—65°F to +200°F	—60°F to +170°F	
Scale Factor Variation	±.01% randomness	±0.01% randomness	
Excitation	6 volts, 3860 cps**	6 volts, 4000 cps**	3.4 volts, 4000 cps***
Natural Freq.	180 cps	210 cps	160 cps
Freq. Resp.	Flat to 250 cps	Flat to 160 cps	Flat to 100 cps
Shock	60 g's	30 g's	30 g's
Weight	4 oz.	7 oz.	2 lbs.

*Available for 180°F.
**Carrier frequency to 100 Kc may be used.
***When tested with Kearfott A3501-01 amplifier.

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Lasers for Intergalaxial Contact?

by Charles D. LaFond

Highlights of OSA spring meeting—important strides in research, vast promise in communications

PITTSBURGH—Contact with intelligent beings in other galaceis (galaxies)—if they exist—could result from use of super-range communications soon to be feasible with advanced laser techniques.

Such a possibility was advanced here during the recent Optical Society of America's Spring Meeting, at which a bumper crop of laser (Light Amplification by Simulated Emission of Radiation) papers were presented.

Twenty-three scientific papers were presented on laser developments of every type and variety before record audiences at the Pick-Roosevelt and Penn-Sheraton Hotels here. The predicted 700-person registration of the nations top optical scientists and engineers was further enlarged by an overflow from the nearly 4,000 attendees of the Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, meeting concurrently.

A highpoint in the meeting was reached with the first symposium—at a joint session—by Dr. Charles H. Townes of the Institute for Defense Analyses, Washington, D.C.

Through the use of laser techniques for intergalaxial communications the first answer to the existence of other civilizations may be found, Townes asserted.

It is within the realm of possibility, he said, that highly intelligent beings exist in other worlds—and may have been trying to communicate with us for hundreds of years.

A good astronomical observatory using the new laser techniques could pick up possible beams of light transmitted from outer space and study them spectrographically.

Four years of travel time in each direction would be required for communication with the nearest star, Alpha Centauri, the former Columbia University professor said, but recognition of such returned light signals would not be difficult.

• **Plasmas investigated**—Spectroscopic measurement of energetic arc plasmas was described by Dr. P. M. Griffin of Oak Ridge National Laboratory, Oak Ridge, Tenn. The laboratory, operated by Union Carbide Corp. for the Atomic Energy Commission, is using spectroscopic methods to evaluate electronic and ionic "temperatures" (mean kinetic energies) of particles in plasmas. Griffin said arc plasmas have been studied, having temperatures ranging from 40,000°F to 1.5 million °F.

A Luce carbon arc (named after its developer, John S. Luce of ORNL) is currently under study which employs a low-pressure, high-current arc between electrodes located in a very strong magnetic field.

Electron temperatures in this system range from 40-100 thousand °F. However, he said, studies of ionic-species Doppler motion indicate positive ion temperatures of from 0.2-1.5 million °F.

In describing the action of these whirling, magnetically confined plasmas, Griffin said they exhibit a tornado-like rotational motion by the ions about the arc axis. Particle velocities, however, exceed that of a typical tornado by roughly 100 times.

Results of this continuing research should provide a better fundamental understanding of plasmas of thermonuclear origin, Griffin said. The temperature differences already revealed between ions and electrons collision may not be as significant as believed previously.

Also, the vortex-like motion could be an important ingredient for sustaining a fusion reaction.

• **Re-entry simulations**—Laboratory simulations to study re-entry problems with high-velocity objects are being performed with extremely sophisticated optical systems, according to a report presented by Dr. I. D. Liu. The Canadian Armament Research and Development Establishment has used such a facility to obtain a high degree of environmental control.

To simulate re-entry, scientists have used a range consisting of a steel tank of from 6 to 10 feet in diameter and several hundred feet long. The tank can be evacuated to simulate any altitude.

Through the tank, scaled models of the test subjects are fired from a hypervelocity cannon at speeds up to 15,000 mph. Since objects traveling at this speed will pass a given observation point in a few microseconds, a streak spectrograph is used, said Liu, to study the light emission produced by interaction of the object and the surrounding atmosphere.

Temperatures of the order of 24,000°K are reached in the shock envelope, with resulting molecular dissociation and ionization. But the light emission is weak and of short duration. Thus, the conventional spectrograph with its narrow light-entrance slit cuts off an intolerable amount of the light emission.

The streak camera, said Liu, employs a series of condensing lenses arranged to funnel the maximum amount of light down to a very narrow area onto the photographic plate.

The system employed is considered economical in all respects, its simplification assists in the interpretation of complex reactions by permitting the isolation of associated phenomena.

• **Optics in space**—Spaceborne optics literally will open the skies for astronomical observation, said Dr. Aden B. Meinel, astronomer at Kitt Peak National Observatory, near Tucson, Ariz.

The balloon-borne telescopes used in Stratascope I (12-in.) and soon to be used in Stratascope II (36-in.) are precursors, but they at least permit viewing the visible spectrum without atmospheric losses. Such systems do not permit observations in the ultraviolet region. Television further enhances their data-collection capability.

Rockets have permitted glimpses from beyond the atmosphere, but observations are transient and not accurately repeatable.

Satellites—and eventually the moon—offer a superb astronomical platform, but for some time to come data retrieval will remain a limiting factor.

In his roundup of "New Frontiers of Astronomical Optics," Dr. Meinel also predicted that high-resolution telescopes will not be employed in space until the 1970's.

However, he stressed that the inherent advantages obtained from using outer space for astronomy will permit a 50-in. telescope to achieve an optimum resolution far in excess of the Mt. Palomar 200-in. instrument—the best currently available.

Potential of Semi-metal Diodes Outlined at APS

NEW YORK—An M.I.T. scientist has proposed a diode made of semi-metals with faster response and lower power requirements, making possible a new control parameter—a magnetic field under cryogenic conditions.

These potentials of substituting semi-metals for the more usual semi-conductors were described recently by Dr. Benjamin Lax, of M.I.T.'s Lincoln Laboratory, at the annual meeting of the American Physical Society.

Such a diode, or "magneto-triode," would be composed of the semi-metals bismuth or antimony, or an alloy of the two, Lax said. The p-n junction would be achieved by doping, consisting of one part per thousand of lead on the "p" or "holes" side, and a similar impurity of tellerium on the "n" side.

Where the energy-level separation of electrons and holes in semiconductors is of the order of one electron volt (ev), that separation in semi-metals would be about 0.05 ev. While the semi-metals employ small degrees of both electron and hole conduction at normal temperatures, doping and operation at liquid helium temperatures removes the overlap, Lax asserted.

At the low temperature, the conductivity can be controlled by application of a magnetic field of the order of tens to a few hundred gauss. Dr. Lax said he thought perhaps a single loop of a superconducting coil would do the job.

• **Doubling performance**—For potential applications in transistors, rectifiers, and switches in computer components, these magneto-triodes would have response times of the order of one-billionth second (one or two orders of magnitude better than present semi-conductors). They would operate in millivolt, microampere and microwatt range.

Such devices would make it possible to operate entire systems in a cryogenic bath, and their noise characteristics would become competitive with masers in amplification.

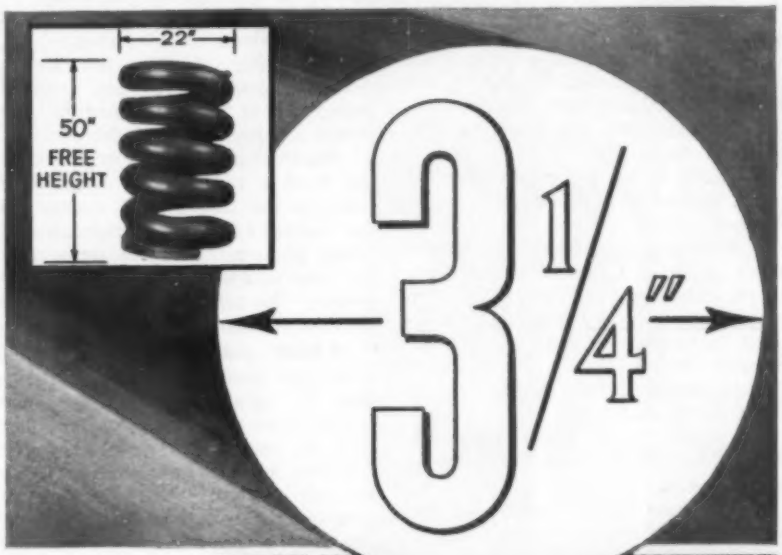
For radar and microwave applications, they could be used in 1-millimeter or 30- to 300,000-megacycle receivers, with very little internal dissipation of power.

Current semi-metal application studies are a result of basic research in magnetic fields and magneto-absorption, Dr. Lax reported. His group is now trying to construct the proper semi-metal alloys, properly doped, for a model using the proposed diode.

Dr. Lax said development of small cooling systems to maintain cryogenic conditions has advanced to the stage where it is practical to thin of an entire computer in the bath with only input and output leads to the outside. ⌗

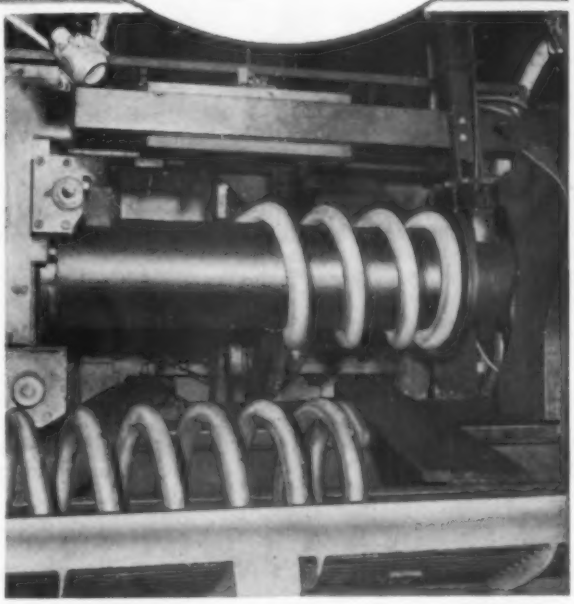
ONLY ASF HAS IT!

New machine coils 3 1/4" bar stock into 22" diameter springs for missile silos



Springs Pass Air Force Inspection

Quality production of the heaviest heavy-duty springs at ASF–HAMMOND Division took another giant step forward recently with the installation of this specially designed machine. It coils 3 1/4" bar stock into half ton springs with 50" free height. These springs are uniform in all essential physical characteristics.



Automatic operation assures unprecedented product uniformity

This new machine automatically controls coiling time to minimize loss of temperature, which assures effective hardening. This results in new standards of uniformity in the heavier springs. If you have a shock-mitigation problem, why not write today for complete information.

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Weather Satellites

(Continued from page 17)

Frank W. Burnett, made these findings:

–Plans for early *Nimbus* launches do not guarantee a satellite in operation at all times.

–The fact that only a single readout station is planned by NASA (at Fairbanks, Alaska) will prevent reading out all orbits and will delay receipt of some data.

–There is need for provision of direct readout of local area pictures by forecast centers.

–Radiation data (from infrared sensors) usable for operations may not be processed on a real-time basis.

–Communications will not be sufficient to transmit to field and foreign forecast offices from the National Meteorological Center the amount of information needed.

–Coverage in the lower latitudes is restricted to one daytime daily view of a given area.

–The time between obtaining observations and the readiness of the resulting weather analyses limits the usefulness of the data, particularly for small-scale forecasting.

• **Continuous system asked**—The Weather Bureau group made these recommendations:

–Procurement of sufficient spacecraft and boosters to assure that at least one *Nimbus* is in operation at all times following the first launch, and acceleration of the development program to assure no further slippage in the first launch.

–Provision of additional readout stations to assure full global coverage.

–Equipment to provide direct readout by ships and land stations.

–Additional communications facilities to assure maximum use of the *Nimbus* data.

–Provisions for operation of two satellites at all times, as soon as the first launches establish the validity of the system.

–Acceleration of data systems design work to minimize the delay between observation and provision of weather analyses to forecasters.

Presumably, the Weather Bureau recommendations have been modified extensively in the three months that POMS has been studying the problem.

The third and fourth *Tiros* satellites will have a modification designed to move in the direction of operational use. Instead of one wide-angle camera, taking pictures 700 miles on a side, and one narrow-angle camera, taking pictures 70 miles on a side, both cameras will be wide-angle.

• **High quality**—Tepper said the wide-angle pictures are far more valuable for operational use, while the narrow-angle shots are more important from the research viewpoint. The first two *Tiros* satellites have provided many research pictures. Provision of two wide-angle cameras will provide redundancy in case one camera runs into focusing difficulty like that of *Tiros II*.

Despite the poor quality of the pictures, Tepper told the Senate committees, *Tiros II* was highly successful. "Considerable cloud information can be extracted even from these pictures. Moreover, the narrow-angle camera pictures are of excellent quality, and the IR data are very promising."

Nimbus, which will weigh about 650 lbs. and will be launched into circular polar orbits of about 600 miles altitude, will be the first weather satellite permanently oriented toward the earth. Ultimately, however, the NASA program calls for an *Aeros* satellite, about the same size and general shape as *Nimbus*, which will be launched into a 24-hour equatorial orbit and will carry a zoomar-type television camera for close-up views of developing storm systems.

Although *Aeros* is not officially approved in the sense that all phases of the program have been okayed at the highest level in the agency, Tepper said there are active plans for developing long lead-time components.

Tepper told the Senate committee that the zoomar camera will be a major problem area. He said NASA is requesting FY '62 budget funds to start developing the camera.

• **Common readout**—Another problem area, he said, is stationkeeping—correcting the equatorial orbit to keep the satellite stationary with relation to the earth to compensate for perturbations introduced by the moon and other factors.

Presumably, work in this area is going on in the Defense Department's *Arents* and *Advent* programs, and in NASA's *Centaur* vehicle development program. Tepper said the first *Aeros* might be launched by a *Centauer* in 1964. He said he hopes to develop a satellite with a lifetime of a year. Major problem in developing long life, of course, is the necessity of a large supply of propellant for course corrections.

While work is in progress on developing a U.S. program, many officials are thinking seriously about how an international program would work. Dr. Harry Wexler, chief Weather researcher who first publicly proposed a U.S. weather satellite program in 1954, believes the funding problem can best be solved by letting each nation fund its own efforts.

Wexler suggests each nation give notice of launchings and that all weather satellites use common frequencies, so that readout stations could obtain data with equal ease, regardless of who owned the satellite.

Even the readout stations will prove expensive for some nations, Wexler notes. Thus it may be desirable for several nations in a region to pool funds for readout stations.

An important technical problem yet to be solved, Wexler said, is that of direct readout by many stations, which might impose a heavy drain on the satellite's power supplies. Also, he said, it may be necessary to provide nonerasible tape for on-board tape recorders. Bigger boosters, capable of carrying greater weight, may be the answer.

Wexler said he was extremely disappointed that Soviet meteorologists were unable to attend a recent meeting of the World Meteorological Organization called to discuss meteorological satellites. Perhaps they will attend the next meeting, he said.

NASA's Nimbus contractors

COMPANY	SYSTEM	AMOUNT*
General Electric	Prime	$2,100,000
RCA	Cameras & solar power	302,324
IT&T Labs	High-resolution IR radiometer	139,235
Santa Barbara Research Center	Medium-resolution IR	343,426
GE	Control & stabilization	1,515,710
GE	5-watt transmitter	92,652
N. Mexico Coll. Agr.	Antennas	69,384
RCA	Vidicon and solar power	In negotiation
California computer	Clock	In negotiation
Ampex	Tape recorder	In negotiation
Radiation Inc.	PCM telemetry	In negotiation

* *Contract sums are for research & development and delivery for first two Nimbus launchings*

AUXILIARY POWER FOR MINUTEMAN'S THREE STAGES

The U. S. Air Force's Minuteman, first of the solid propellant powered ICBM's, introduces numerous design and operational features unavailable in its first generation counterparts. End result is a smaller, lighter, less complex and lower cost missile.

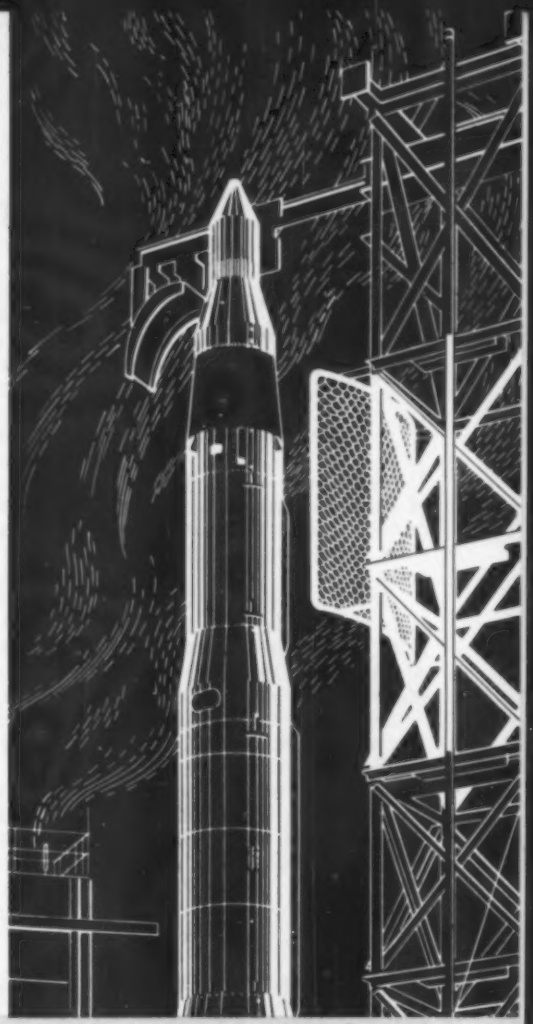
COMPACT DESIGN—Typical of these advances is the highly integrated APU design developed for all three missile stages by Vickers under contract to Autonetics, a division of North American Aviation, Inc. A significant saving in package weight and envelope is provided by immersing the hydraulic pump completely within its self pressurizing reservoir.

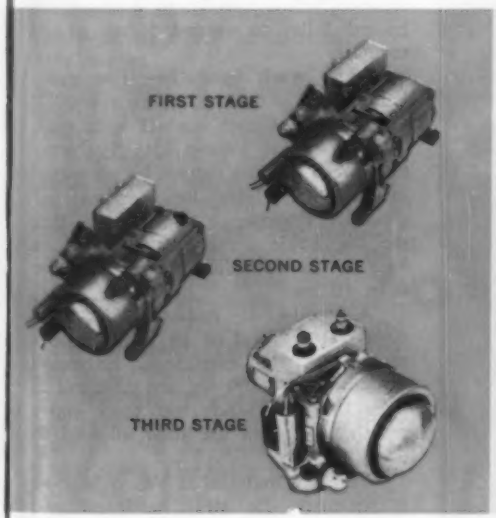
APPLICATION FLEXIBILITY—An important design feature is the ability of the hydraulic pump to be coupled with a wide variety of drives including continuous duty electric motor, ram air turbine, hydraulic motor, flywheel, or be mounted directly on an engine drive pad. For the Minuteman application, an intermittent duty d-c motor is used.

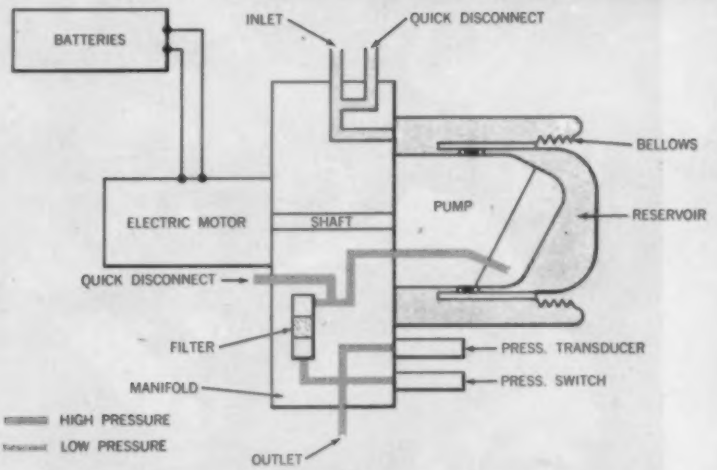
UNUSUAL STORAGE LIFE—A fundamental design goal of the Vickers Minuteman APU was to match the unusual storage life of the missile. This has been accomplished to provide long service-free standby in the missile, coupled with convenient ground check-out.

HIGH RELIABILITY—The schematic diagram below shows the absence of external tubing and the requirement for only one external dynamic seal. These factors along with a proven pumping element and relative low operating speeds have led to a highly reliable system.

This solution is typical of the Vickers "Programmed Power" approach to energy conversion, power transmission and fluid transfer. Get more details on this application by writing for Bulletin A-5249.







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9421

Tapco Explores Tungsten Fabrication

Details of Group's effort to find methods for shaping host of future space parts

by John F. Judge

CLEVELAND—The Tapco Group of Thompson Ramo Wooldridge Inc. is moving along on a carefully planned effort to develop structural tungsten parts.

The Group's Materials Department is in the middle of a five-phase program, sponsored by the Air Force's Air Materiel Command, which began where the current state of the art ends.

Tungsten and tungsten-alloy forgings are expected to be used in manned glide vehicles, re-entry nose cones and leading edges, nozzle throats and blast control vanes, combustion chamber hardware and structural parts for nuclear engines—to tick off a few applications.

But the manufacturing processes required for fabrication of such parts are virtually nonexistent. Dr. A. S. Nemy, research supervisor of the Tapco program, says tungsten " . . . is at the state of development today that columbium was in 1956."

• **Extrusion avenue**—Tapco examined the possible routes of tungsten conversion to bar stock (rolling, swaging, forging and extrusion) and concluded that extrusion, for most applications, offered the best potential.

The firm has successfully extruded reproducible tungsten-alloy forging billets. The alloy chosen was W-15% Mo. Nemy now suggests including a small number of dilute tungsten-base alloys such as W-0.88% Cb and W-7% Mo. He is also eyeing W-0.1% Zr., an alloy which has a large potential but is not yet commercially available.

Cost, properties and design flexibility are the main reasons for the forging program. Nemy says the missile industry would welcome an improved production method of forging throat inserts from tungsten. It would be ideal if thin, integrally stiffened sheets of the metal could be fashioned for exit cones. And there are always the added property values obtained from actually working the tungsten during fabrication.

Tapco's forging plans call for closed-die, precision forgings. This involves three-directional metal flow in the workpiece—a difficult task with a high-melting, obstinate material like tungsten.

The extrusion process is carried out on a 700-ton Loewy horizontal extrusion press. An air-water accumulator system permits pressure loading of up to 184,000 psi on the upset billet. The valving is such that no-load speeds in excess of 30 in./sec. can be achieved, and the press has been operated at 23 ips under 100,000-psi loading. The Loewy machine is approximately five times as fast as commercial extruders.

All billets are heated in a unique, inert-atmosphere induction furnace powered by a 30KW motor generator set operating at 4200 cps. The furnace opens upwards completely in three seconds. Billets are manually-transferred from the furnace to the press in approximately four seconds. The entire press operation consumes another three seconds, which puts the total time from heated billet to extruded bar at 10 seconds.

• **Die wash headache**—The problem centers at the die, where a 4000°F billet is in intimate contact with steel, which melts at around 2500°F. Nemy says that the billet cannot be permitted in the steel liner longer than 0.5 seconds. Experience has shown that the die holds up reasonably well as long as the extruding speed is greater than 10 ips.

A sand-filled run-out box positioned at the end of an 8-ft., run-out tube stops the extrusions. Extrusion velocities, 40 to 60 ips, are sufficient to bury them in sand over their entire length. The bars are then allowed to cool.

Base die material is Vasco Marvel, a hot-work die steel hardened and double-tempered to R_c 50. The entrance face of the die is tapered to a 120° included angle. A portion of the face is recessed 0.020 in. to provide a seat for insulative and lubricative coatings.

Nemy has been using Al_2O_3 as an insulator in this recess, but future dies will use zirconia. In addition, the lead-in angle will be flattened and the relief

WHITE-HOT TUNGSTEN BILLET is positioned in the extrusion press. Three seconds later, the extruded rod will bury itself in a recovery sand box and cool.

angle decreased to provide more seating strength.

Tapco has established the homogeneity of each extruded bar and uniformity from bar to bar. The results are relatively insensitive to the source of billet supply and the method used in forming the billet.

Billet lubricity has been investigated, but Tapco usually relies on the volatile WO_3 formed during the billet transfer. However, too much of the oxide can cause extrusion difficulties.

Reproducibility tests involved the ductile-brittle transition temperature—an extremely sensitive indication of the interstital impurity level; response to heat treatment (recrystallization is indicative of the amount of cold work in the extrusion process); and upset forgeability (the ultimate criterion of reproducibility is the forging itself).

During these tests it was established that the billet stock transition temperature was a low 500°, the forgeability temperature was an equally low 2000°F.

Tapco is not a commercial extruder of common metals, but the unique combination of furnace and press has led to many cooperative programs with uses of refractory metals.

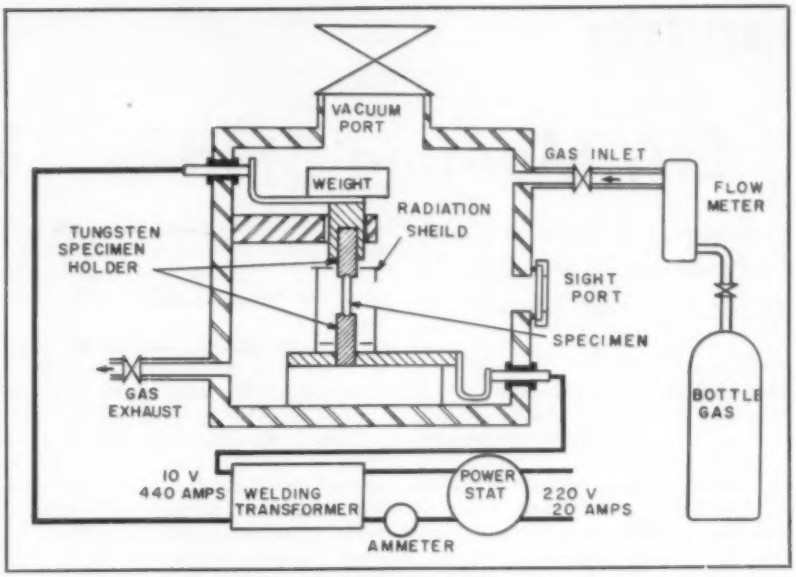
• **Structural forgings**—The next steps in the program move into closed-die ring forging tests. By the end of May, Tapco expects to have forged thin section web structures. A universal forging die will be developd to embody different angles and depths of fill. The results of forging operations with such a die will be translatable to other shapes.

With regard to the fabricability of sprayed-tungsten forms, Nemy says success or failure seems to hinge on the little variables in spraying—purity, atmosphere and speed, to name a few. When successful, such a part is at least as good as a similar one fashioned through powder metallurgy methods.

The results of three years' experience with the forging of columbium alloys at Tapco has contributed to the development of techniques being used in the current tungsten program.

• **Backside reactions**—Tapco has been probing the compatibility of the materials used in rocket nozzles for several years. The study has led to the development of a materials compatibility test chamber which simulated the chemical atmosphere and temperatures of a rocket nozzle.

G. J. Guarnieri, manager, Materials Development, points out that improper materials selection can lead to the formation of low-melting-point constitutents in the critical nozzle throat area. Similar problems may occur as exhaust temperatures are pushed higher and cooled nozzle approaches are adopted. The reaction-studies chamber is being modified to accommodate studies in this area.



Nozzle Materials Compatibility Chamber

Current research at Tapco is aimed at determining the problems lurking in these nozzles. Initial programs will determine the likely coolants; then compatibility studies will begin. Once screening has been accomplished, plasma tests will follow; then, subscale nozzles.

The plasma jet is being used both as a fabrication tool and as a testing device for material evaluation. For evaluation purposes, Tapco had to determine the heat flux distribution across a plasma flame. Empirical studies involving all grades of graphite are an integral part of the nozzle program. Tapco's bench findings are in good agreement with test-firing results.

Guarnieri feels that major factors in the deterioration of graphite in nozzles are chemical reactions and mechanical erosion.

For nozzle inserts, the industry is expanding the use of tungsten. The composite of tungsten inserts with other refractory back-up materials gives rise to a materials compatibility problem. Researchers have learned that certain reactions occur between nozzle structural materials resulting in lower melting temperature products. One solution has been to place a barrier—such as a thin layer of zirconia—between the reactive constitutents.

In the exit cone area, it is likely that phenolic-impregnated graphite cloth or fibers will be the next step. The main problem to be licked is in the processing of the graphite material. Reproducibility and reliability have not yet been attained.

Tapco's activity in exit cones ranges from uprating present compositions to investigating any kind of inorganic refractory fiber material available. The search for better fibers has already resulted in laboratory evidence of the superiority of zirconia to current silica reinforcing compositions with respect to erosion.

Compatibility data is also being compiled with liquid metals. The success of future solar thermomechanical and nuclear space power systems will depend on adequate knowledge of containment materials for these working fluids.

• **Bent tube tests**—One aspect of these studies involves a cost-cutting innovation in the gathering of corrosion data. The usual method is the loop test—a miniature system duplicating the heating and cooling cycle followed by liquid metals in an engine such as the Rankine cycle.

Tapco came up with a simple pyrex or Vycor glass tube, bent at right angles, housing the liquid metal in one end and a corrosion specimen in the other. When heated, the system acts like a reflux condensor, continually depositing fresh liquid metal on the sample. The bend orifice is critical.

Almost 800 bent tube tests have provided information on specimen corrosion, surface treatments, coatings, liquid metal additives, and corrosion/time data. The cost of obtaining the same information from loop tests would have been between $2.5 and 3 million. The actual cost was less than a tenth of this.

Only certain flow rates are possible with the bent tube test; for this reason, thermal gradient data must be obtained on loop tests. Tapco has run the tests up to 1200°F and plans to go higher. ¤

EIA Meeting Studies 'Limited War'

Seminar will give industry first look at new plans for 'brush-fire' war capacity

"LIMITED WAR" will be the theme in military electronics at the Electronic Industries Association Annual Spring Conference in Washington, D.C., March 14-17.

Lead-off event at the four-day meeting in the Statler Hilton Hotel is scheduled to be a seminar on "Planning for Limited War Requirements." At a luncheon the same day, Army Secretary Elvis J. Stahr, Jr., will discuss the U.S. defense posture; it will be his first major address in the capital since his appointment.

The all-day seminar is expected to give industry its first authoritative picture of the new Administration's plans for America's small-conflict capability.

William Bradley, associate director of research at the Institute for Defense Analyses, will deliver the keynote address on the "Logic of Limited War."

David R. Hull, past president of EIA, will be chairman of an otherwise all-military discussion panel including Brig. Gen. J. T. Snodgrass, USA, Rear Adm. J. A. Jaap, USN, Brig. Gen. R. C. Richardson, USAF, and Brig. Gen. B. A. Hochmuth, USMC.

The annual Government-Industry Dinner (black tie) on Thursday, March 16, will feature an address by Lt. Gen. Bernard A. Schriever, chief of the AF Research and Development Command. He will discuss the role of electronics in space before an invited audience of more than 500 government, industrial, congressional and military leaders.

Other conference highlights include:

–March 15 (AM): seminar on problems of small electronics manufacturers.

–March 15 (PM): seminar to analyze the impact of the Darnell Report on Parts Specification Management for Reliability.

–March 16 (AM): seminar on space satellite communications.

With a record 43 business sessions scheduled, many of the EIA committee meetings also will be held at the nearby Willard and Mayflower Hotels. ⁂

Martin Shows Its 'Audio-automation'

CAPE CANAVERAL—Missile support equipment can now be automatically controlled by audio signals pre-recorded on magnetic tape. The prototype of such an "audio-automation" system was recently demonstrated by The Martin Co. at a *Titan* launch site here.

In experimental tests, a flame-bucket water system was automatically controlled from a station 300 yards away. The unit can direct two channels of operations and produce 31 automatic control signals at one time. In the demonstration, two independent water systems on the test stand were operated simultaneously.

Martin says the audio-automatic programer may also be used for checkout and maintenance of equipment, training and simulation, as well as for actual operation of support equipment.

The programer consists of a two-track recorder which provides automatic control tone signals to specified equipment and, at the same time, verbally describes the control command to an operator. The operator monitors the progress of the operation by observing lights on a control panel. The lights indicate the equipment's compliance with the automatic control signal.

If a piece of equipment fails to carry out the command of the tone signal, the operator halts the operation by stopping the tape recorder until the trouble is cleared. Starting the recorder continues the operation.

The tone signals on the tape are coded by using select frequencies. When the signals are received by the equipment they are decoded by means of a frequency-sensitive network. Decoded tone combinations provide the proper automatic control signals to the equipment under operation.

Tape recordings may be prepared in advance of an operation, and used at any desired time. Each recording program may be used over and over again. The signal may also be sent from the recorder to the equipment either by wire or by radio.

The audio-automatic programer is adaptable to systems in missiles, manned aircraft and manned space vehicles. ⁂

Burroughs' President Cites Costs of Research Funding

IT COSTS MONEY to achieve corporate competency today, according to Ray R. Eppert, president of Burroughs Corp. Earnings must be kept up to meet the need for heavy expenditures in R&D, as well as to maintain a potent marketing team.

During the last five years, he told the New York Society of Security Analysts recently, Burroughs has spent over $75 million in its R&D program (or nearly 6% of its 1955-1959 total gross.) With over 25% of its total revenue from military electronics products, the company intends to keep its pure and applied research level high during 1961, said Eppert. To indicate how this investment in pure research pays off, he said the company has just announced the first commercially available thin-film memory planes.

But Eppert said developments aren't enough. To market such advances Burroughs employs a current marketing team totaling almost 14,000 persons. ⁂

Navy Adds Money for Polaris Sub Transmitters

INTERIM FUNDING by the Navy of an additional $986,000 to Hoffman Electronics Corp. for further development of advanced high-powered transmitters in the high-frequency range will spur work along in this vitally needed equipment for new *Polaris* nuclear submarines.

New funds cover R&D and production of eighteen units, bringing the total allotted so far to nearly $6.5 million. Initial deliveries already have been made, said the Navy.

Designated the AN/WRT-4, the transmitters are designed to meet the unusual requirements demanded by these advanced ships, but they are also adaptable to any other vessel, land vehicles, or even hardened missile sites, according to Hoffman engineers. The WRT-4 employs a fully retractable whip-type antenna. ⁂

AF Funds Further Work On B-52 Navigation

THE AIR FORCE has released $20 million for design, development, and integration of an improved bombing-navigation system that will enable the B-52 to accurately launch ballistic missiles such as the *Hound Dog*.

The ASQ-48 system—now being flight-tested—greatly improves the complete weapons system capability and potential of the SAC jet bomber.

AC Spark Plug, electronics division of General Motors, is system contractor for the ASQ-48. Total funding for production is expected to exceed $50 million.

The new system uses radar and an automatic computer to navigate the bomber both for high-level bombing and low-level flying to avoid enemy radar detection. ⌗

—reviews—

MEN OF SPACE, VOL I, Shirley Thomas, Chilton Co., Philadelphia and New York, 235 pp., $3.95.

Miss Thomas consulted with important men in the space field and came up with 10 names of men who are "epoch makers" in the conquest of space. Maybe so, although some readers of the book might consider that some of the choices at most titillated, rather than significantly contributed to, space flight sciences.

Here are her choices: Krafft A. Ehricke, Robert H. Goddard, Bernard A. Schriever, John Paul Stapp, Konstantin E. Tsiolkovsky, James A. Van Allen, Wernher von Braun, Theodore von Karman, John von Neumann, and Charles Yeager.

The biographies are clearly written, and with a great deal of color. They deal at length with the human elements of the men many of whom we know only by their technical work. Miss Thomas is amply suited to write in this fashion through her work as a Hollywood interviewer-commentator for NBC, CBS and the Voice of America.

DIGITAL APPLICATIONS OF MAGNETIC DEVICES, Senior Editor, Albert J. Meyerhoff, John Wiley & Sons, Inc., Publishers, 581 pp., $14.

This book provides the necessary theory for the design of the major digital magnetic circuit types, and complete design examples of several specific systems.

It is sufficient, in many cases, to enable the professional computer engineer to determine the solution to such problems as: the suitability of a magnetic circuit; the specific component types to be employed; design procedures necessary to design complete systems; specific steps and equations involved in circuit design; and, in great detail, the particular effects of specific parameters of magnetic core characteristics and geometry on circuit design and performance.

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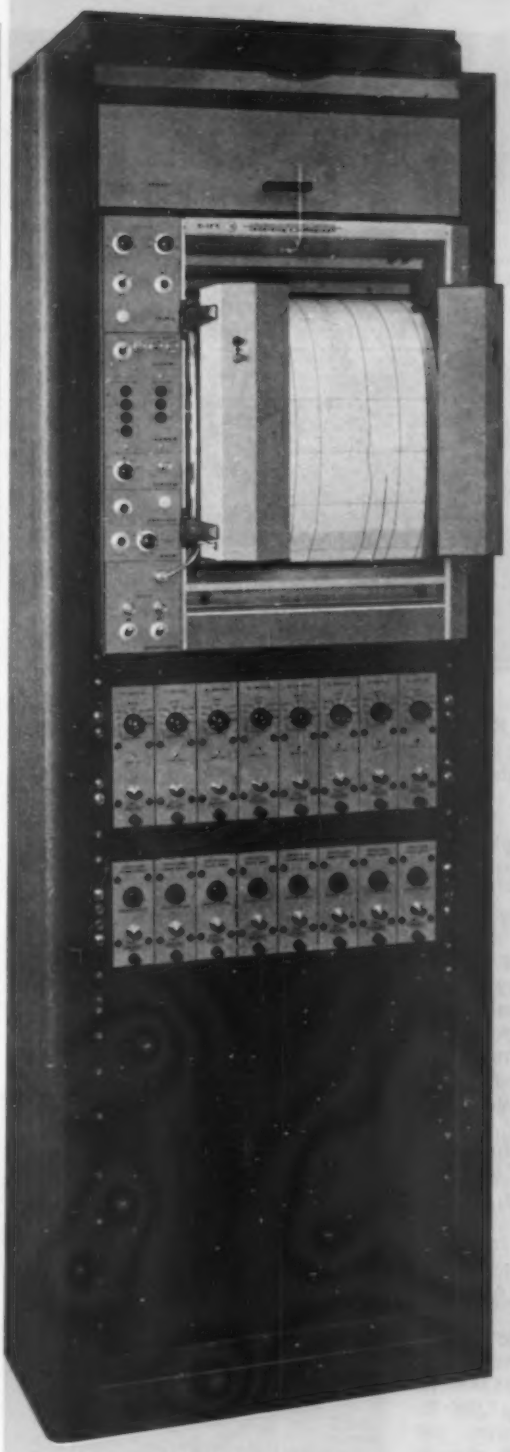

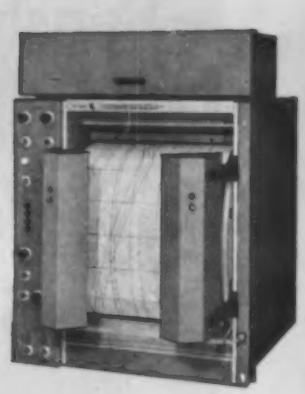

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Banshee H E Blasts Will Probe Near Space

by Richard van Osten

NIKE-HERCULES missiles with high-explosive warheads will be fired at balloon-borne targets this summer as part of the Defense Department's Project *Banshee*—a tri-service program to investigate the dynamics of high-altitude explosions.

The two-phase program is jointly administered by the Ballistic Research Laboratory, Aberdeen Proving Ground, and the Naval Ordnance Laboratory, balloon support and launch provided by the Air Force Cambridge Research Laboratory. Tests will take place beteen June and November at White Sands Missile Range, N.M.

In the first phase of *Banshee*, a high-explosive charge and blast instrumentation will be carried to altitude by a balloon (stationary charge and stationary instrumentation).

For Phase II, the balloon will carry blast instrumentation to altitude and serve as a target for the *Nike-Hercules* missiles (moving charge and stationary instrumentation).

Balloons will be launched from sites at WSMR with an additional off-range launch site at Air Base City, Hobbs, N.M. Dry-run launches minus explosives will be conducted from the Hobbs site prior to actual operational flights to obtain balloon rate of ascent and flight trajectory data.

The balloons may as large as 5.27 x 10^6 cu. ft. in volume. Diameters will run from about 66 ft. at 38,000 ft. altitude to about 240 ft. at 115,000 ft. Balloon length will vary between 100 ft. and 335 ft. over the same altitude range.

In Phase I, 10 balloons with instrumentation systems and explosives will be launched. One will be launched from WSMR. Nine will be launched from the Hobbs site, with three balloons each slated for ascents to 85,000, 100,000 and 115,000 ft.

Phase II operations will include the launch of seven balloons carrying instrumentation systems, but without explosives. One will be launched from WSMR to an altitude of 38,000 ft. Six will be launched from Hobbs—three targeted to 100,000 ft. and three for 115,000 ft.

The balloons will be fabricated of translucent polyethylene and filled with helium. A safety parachute will be suspended below the balloon, and the instrument train will be suspended 200 ft. below the chute.

• **Configuration**—Instrumentation, located at different levels on the 200-ft. extension, will consist of a command control and recording package, four pressure-sensing transducers and a 500-lb. high-explosive charge. The charge will be carried only in Phase I tests. Total weight of the Phase I system will be about 1000 lbs.

Additional instrumentation for the balloon vehicle will consist of a radar beacon and, for Phase II, a pyrotechnic flare which will be ignited by ground command from WSMR to determine miss distance between the balloon and *Nike-Hercules*.

The entire test vehicle, including instrumentation, will be launched as a unit with the 200-ft. instrumentation train deployed from the launch vehicle. This configuration will persist throughout the flight and parachute recovery.

All flight equipment, except the 500-lb. explosive charge and possibly the sensing transducers, will be recovered by a standard, 64-ft. cargo parachute. As suspended below the balloon, the parachute has an overall length of about 80 ft.

Flight duration is dependent upon the altitude desired, varying from two hours to eight hours. It is planned to make all launches and flights during daytime hours. With the instrumentation train, minimum ascent rate is expected to be approximately 500 fpm. There are no plans to have the balloon descend but, if necessary, it will drop at about 500 fpm between 44,000 ft. and the surface.

• **Safeguards**—For safety reasons minimum weather conditions have been established, and the balloon vehicles will be tracked by instrumentation at WSMR. Final launch decisions will rest with WSMR. If there should be any malfunction at vehicle launch, the system provides for release of the parachute, instrument train and explosive charge into an area designated as "safe" prior to launch, or the charge may be detonated before release of the equipment.

The vehicle's minimum rate of ascent between the surface and 44,000 ft. will be 500 fpm. The 44,000-ft. altitude must be reached within 100 minutes, after which the balloon will be tracked continuously and trajectory predicted. Test will not be conducted when trajectory predictions indicate it will not be successful. In that case, the charge will be detonated upon command and the parachute and instrumentation released in a safe area while the balloon rises and eventually bursts.

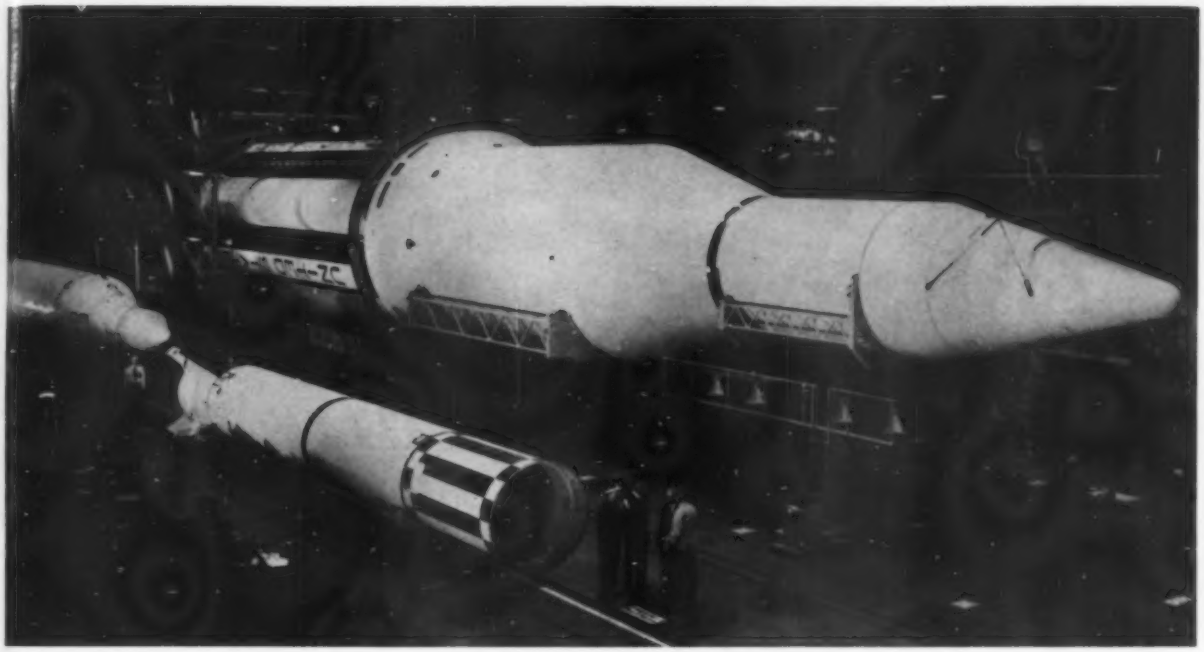
For further safety, although the general area is sparsely populated, all detonations and/or *Nike-Hercules* firings will take place only if the vehicle is within the confines of WSMR.

The balloon will be escorted by an aircraft during the flight portion conducted outside of WSMR. Tracking and test status information will be coordinated by land-line communications. ¤

Heart of DOD's Global Communications

NATIONAL DEFENSE Communications Control Center, heart of a worldwide monitor and control complex, began operation last week under the direction of the Defense Communications Agency, in Arlington, Va.

Built by Philco Corp. around its S-2000 digital computer, the center will receive, process and display data reflecting conditions of all the military's non-tactical communications networks. In time, system control will be decentralized at logical areas around the world, and the data base of this center will be enlarged—with the eventual goal of real-time control.



Saturn Moves Nearer First Flight

SATURN BOOSTER MATED with dummy upper stages delivered by Douglas and Convair lies on its side in hangar at NASA's Marshall Space Flight Center, Huntsville, Ala. Flight booster will replace prototype on static test stand in next few weeks. After completion of static and dynamic tests at Huntsville, the flight version of Saturn will move by barge to Cape Canaveral for launching late this summer. Much time lost last fall was made up when NASA discovered that only four firings were needed in the second series of prototype booster static tests, which ended last month.

Scout Advances

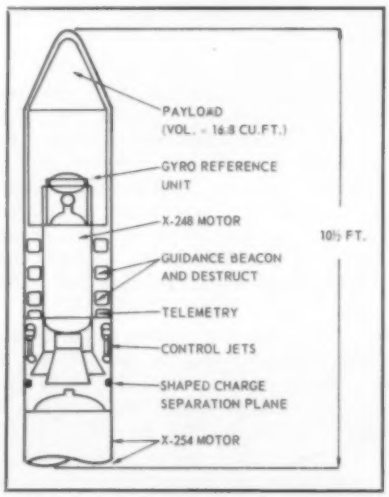
Successful Flight with Fourth-stage Guidance

BLUE SCOUT II—first *Scout* vehicle with guidance in the fourth stage—lifted a 172-lb. payload to an altitude of 1580 miles in its first flight March 3.

The payload, which remained attached to the empty X-248 fourth-stage rocket case, contained six experiments designed by the Air Force Special Weapons Center. The Air Force said radio telemetry information was received from all six on the 40-minute flight before burnup 2000 miles downrange from Cape Canaveral. The experiments were:

Proton telescope, to measure energy flux and angular distribution; electron spectrometer, to measure energy flux and angular distribution; gamma-ray detectors, to measure energy and intensity; neutron detectors, to measure energy and flux; tissue equivalent ion chamber, to determine total radiation exposure at depth of 2 cm in human tissue; Schonstedt magnetometer, to measure intensity of earth field.

Blue Scout II is the third in the Air Force family of vehicles based on the *Scout* to be tested. Its stages are identical with those of the basic *Scout*, developed by the National Aeronautics and Space Administration. The major difference is the addition of fourth-stage guidance.



CUTAWAY of Blue Scout II payload carrier.

Ford Aeronutronic Division is prime contractor to the Air Force. Chance Vought, prime contractor to NASA, is vehicle assembly subcontractor to Aeronutronic.

The Air Force said five more high-altitude probes are scheduled before the first *Blue Scout* orbital try. ⌗

Thermoelectric Sulfides Produced by Westinghouse

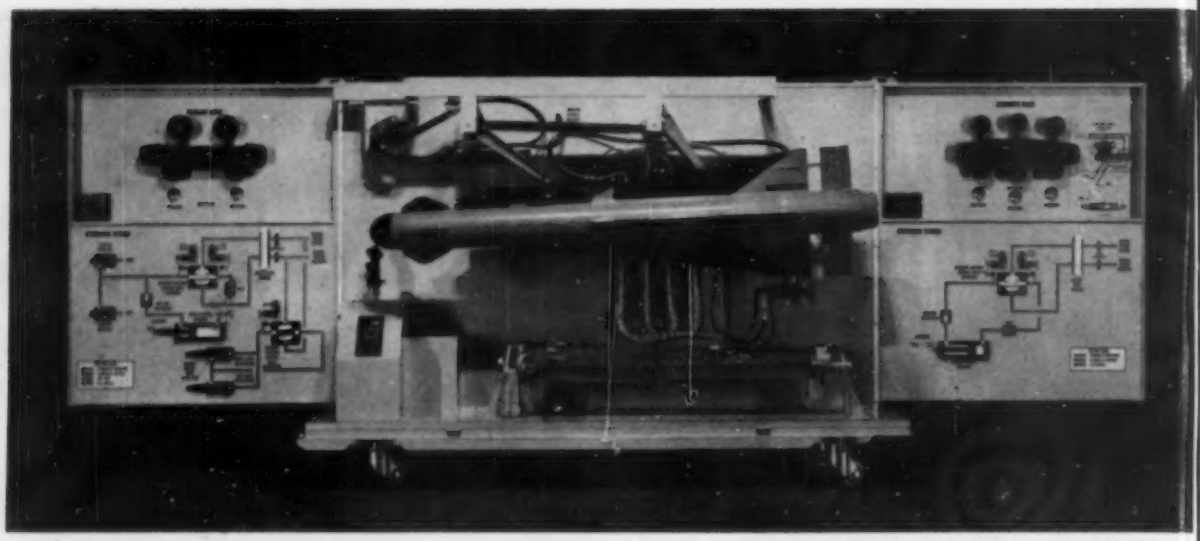
COMBINATIONS of the rare earth metals, samarium and cerium, with sulfur have produced two new groups of high temperature thermoelectric materials at Westinghouse Electric Corp.

The compounds show stability and attractive thermoelectric efficiencies at temperatures up to 2000°F. They can be used at the top of a series or cascade of thermoelectric materials in future power generators. Each series operates in the narrow temperature range at which it functions best and each passes its waste heat along to the next lower temperature material on the scale.

Thus a generator can be operated at a higher temperature, raising the overall efficiency.

The two families of rare earth sulfides are prepared by direct combination with sulfur. Following the reaction, the sulfide is crushed and compacted into cylindrical pellets and sintered. Composition is determined by X-ray diffraction analysis. Physical, chemical and electrical tests are then run on the pellets.

The development is part of a continuing research and development program sponsored by the Navy's Bureau of Ships. ⌗



TYPICAL OF Burtek's contribution to missile training in this Falcon trainer.

management

How Tulsa Firm Moves With Missiles

HILBURN

WITH MORE and more missile systems moving from research and development into the operational phase, missile training aids are gaining in importance as a market. One firm with a strong capability in this field is Burtek, Inc., of Tulsa, Okla.

The firm is the largest builder of training devices for the *Polaris* program, with contracts from Lockheed Aircraft Corporation, General Electric and the Navy.

Its missile control center console, an exact duplicate of the shipboard panel, is in use at the Navy's Pittsfield, Mass., *Polaris* training school. It was used to train crews for the first underwater launch.

Burtek also builds the airborne pressurization and propellant feed system trainer for the *Atlas* program. Now in operation at Sheppard AFB, Tex., this permits the instructor to program predetermined malfunctions which are concealed from students as they progress through countdown prior to launching.

Although successful in the field of training aids, Burtek has no intention of limiting itself to these. With training aids as a base, Burtek is now putting together a number of diverse talents, particularly in electronics, for more general growth in missile/space technology.

The expansion began a year ago when Earl D. Hilburn, a former vice president of Link Aviation, unceremoniously took over the reins of Burton-Rodgers, Inc.

His first move was to acquire the electronics division of Divco-Wayne Corp., Cincinnati, producer of radar moving target indicator (MTI) test equipment and specialized frequency meters. Now, as the Electronics Division of Burtek, it also builds specialized cathode ray oscilloscopes, multi-circuit cable testers, microwave stability indicators and special purpose communications gear.

Next was streamlining of the name. Hilburn chose Burtek to reflect the Burton-Rodgers heritage as well as that of Technical Training Aids, Inc., which the firm had acquired in 1955.

Construction of a centralized, $500,000 headquarters for the firm was started in Tulsa. It is scheduled for completion this month.

• **Concord added**—Two months ago, Burtek annexed Concord Control, Inc., a Boston firm specializing in digital computation, data handling and control systems engineering.

Concord has broadened its research activity into other areas, including automation of map and chart preparation for the Army Map Service, radio-controlled buoys and other instruments for oceanographic studies, and data logging and control devices for use with radio telescopes.

One device is an expendable instrumented buoy designed for more reliable and less costly location of impact areas in missile and satellite recovery operations. Under study is a system for electronically calculating and correcting distortion due to camera angle and earth curvature in photos taken from satellites.

Missile training equipment is one area eyed by Hilburn for major expansion. Although faced by competition from prime manufacturers interested in keeping this business under their own roof, he expects the general shift from the R&D to operational phase for missiles to create new repetitive training needs more in line with Burtek's talents.

• **More people**—In the meantime, with a free hand from 18 stockholders holding about a million shares, Hilburn is concentrating on expansion, diversification and, where the opportunity presents itself, new people. His latest addition is Edward G. Schwarm, former President of Applied Dynamics, who will be General Manager of the Tulsa operation.

Sales offices have been set up in Los Angeles, Dayton, Washington and New York. As the operations expand, these corporate sales offices will handle the marketing function for all divisions and subsidiaries.

Hilburn clearly intends to make Burtek a strong competitor in missile/space electronics. His first year as president has gotten him off to a good start in that direction. ::

North American's Aerospace Laboratory

A look at $10-million facility designed to further enhance NAA's missile/space capabilities for the future

EL SEGUNDO, CALIF.—North American Aviation, Inc., boasts the world's largest acoustical facility, environmental test chamber and privately-owned wind tunnel at its new $10-million, 28-acre aerospace laboratory.

The acoustics unit is built around a centenary horn 71 ft. long, 49 ft. wide and 28 ft. high. Equipped with two sirens powered by two 400 hp electric motors, the unit provides for discrete frequency or random noise at sound pressure levels up to 170 decibels, about one billion times that in a busy office.

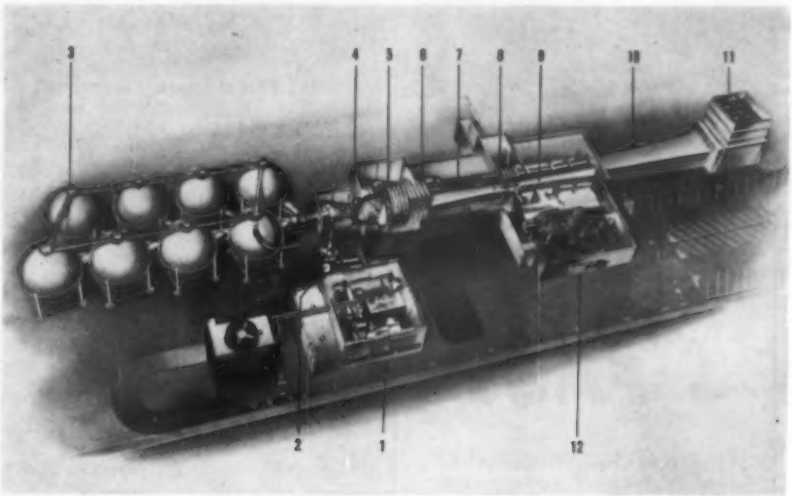
Provision is made for grazing or normal-incidence specimen orientation, progressive wave or reverberant sound field, frequencies of 50 to 10,000 cps and temperatures ranging from −100° to +1200°F. The throat of the horn will accommodate specimens up to 3 x 5 ft.; the main test room holds an object 6 x 25 ft.

In the 22 x 90 ft. environmental test chamber, the entire forward fuselage section of the B-70 bomber is subjected to altitudes and temperatures up to 140,000 ft. and 2100°F. Rear section of the chamber retracts on rails from the instrumented forward shell.

The new wind tunnel is designed for aerodynamic investigations to Mach 3.5. The intermittent blowdown-type facility accommodates 7 x 7 ft. test sections.

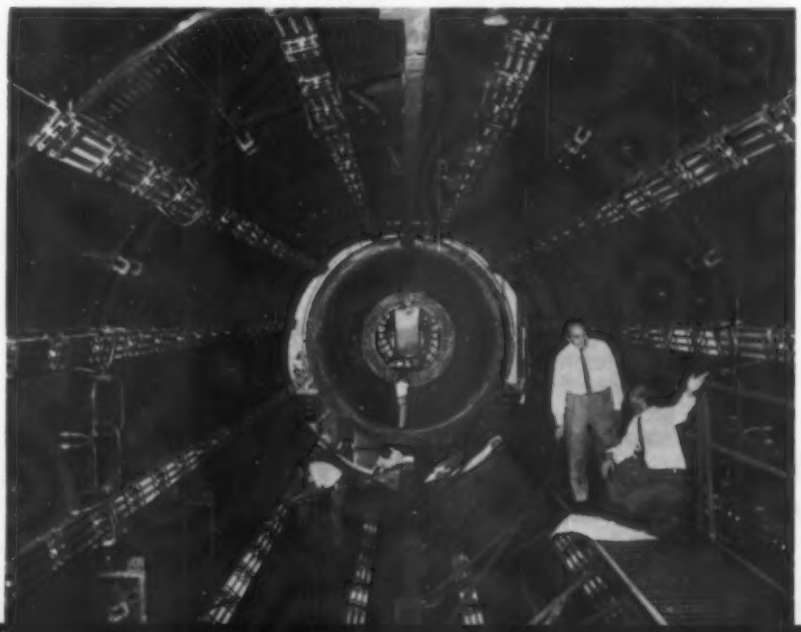
The installation also includes a radome and antenna test facility, a general laboratory and a structures laboratory. A space environmental chamber to test full-size manned capsules at 120 miles altitude will be added. ⌗

AEROSPACE LABORATORY, an "earth station for space men," includes world's largest sonic test facility, environment chamber, and privately owned wind tunnel.



SKETCH OF TRIOSONIC Wind Tunnel shows 1) compressor building, 2) air dryer, 3) air storage spheres, 4) control valve, 5) settling chamber, 6) fixed nozzle, 7) flexible nozzle, 8) test section, 9) variable diffuser, 10) fixed diffuser, 11) muffler building, and 12) test building. Installation was first completed.

ENGINEERS CHECK radiant heat lamps in the 500-ton environmental chamber.



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names in the news

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Herbert R. Keith: elected president and a director of The Service Bureau Corporation, New York, N. Y. **Frank T. Cary,** former president, promoted to an assistant director of the corporate staff of International Business Machines Corporation, the parent organization.

Charles Thomas: named superintendent of missile propellants for Pan American's guided missiles range division at Cape Canaveral, Fla.

Dr. Frederick Seitz, head of the Physics Department of the University of Illinois, elected a director of American Machine & Foundry Co., New York. Dr. Seitz also is chairman of the Naval Research Advisory Council and president of the American Physical Society, as well as the author of several books on physics and co-editor of a survey series on solid-state physics.

Dr. Leland I. Doan, president of The Dow Chemical Company, elected a director of The Bendix Corporation, South Bend, Ind.

Dr. George Pheler: professor of solid-state physics at the University of California at La Jolla, awarded the 1960 American Physical Society prize for developing a method of examining the structure and behavior of atoms in semiconductor materials. Dr. Pheler's development is called the electron-nuclear double resonance technique.

William W. Drake, Jr., named corporate treasurer and will continue as vice president-administration of Aerospace Corporation, Los Angeles. **Robert T. Jensen,** former corporation counsel, appointed assistant secretary and general counsel.

Cheuk W. Leung: joins Electro-Optical Systems, Inc., Pasadena, Calif., as research scientist in the solid-state division, where he is engaged in research on the high-temperature thermal and electrical properties of semiconducting compounds and alloys. **William H. Foster** and **Keith L. Winsor** join the Advanced Electronics & Information Systems Division as manager of the advanced technology department and manager of the advanced electronics department, respectively.

Dr. Louis B. Werner: joins Hazleton-Nuclear Science Corporation, Palo Alto, Calif., as vice president. Prior to his appointment he served as scientific representative with the U. S. Atomic Energy Commission in the United Kingdom and Ireland.

John C. Forrest and **Dr. Frank N. Gillette:** promoted to the respective positions of director and associate director of the engineering division of GPL Division of General Precision, Inc., Pleasantville, N.Y. **Louis L. Pourciau** is now head of the industrial products department of the engineering division.

Col. Thomas W. Cooke: Named Commander of Redstone Arsenal, Ala. **Col. Foster L. Furphy** succeeds Cooke as AOMC Chief of Staff.

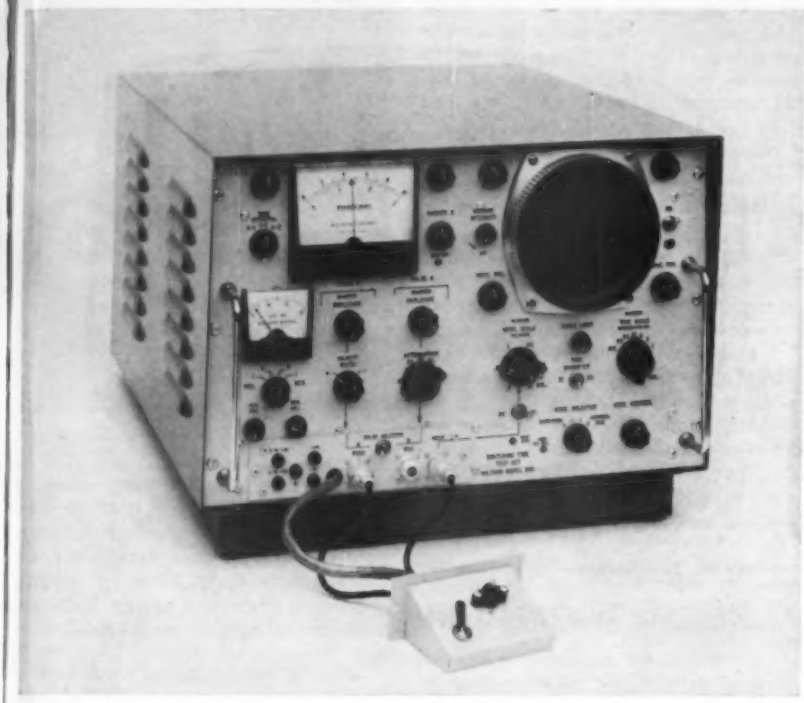
Dr. Jack E. Froehlich: Named general manager of Space Electronics Corporation's new Applied Science Division, Glendale, Calif. Dr. Froelich is noted for his project leadership on *Explorer I.*

Col. Harold W. Norton: Nominated to receive the USAF Research and Development Award. He is director of rocket propulsion at the Flight Test Center, Edwards AFB, Calif.

Dr. Choh-Yi Ang: Appointed manager of Telecomputing Corporation's newly organized Physics Research Laboratory, San Diego, Calif. The laboratory is conducting investigations on energy conversion, new types of electronics devices, and solid-state materials.

John J. Roscia: former assistant general counsel, elected vice president and general counsel of North American Aviation, Inc., Los Angeles. **Gerald B. Brophy,** senior vice president and general counsel, becomes senior counsel advising the board of directors, the chairman and the president on special matters.

Robert W. Mayer: Appointed manager-engineering for General Electric's Ordnance Department, Pittsfield, Mass. With GE since 1942 and a recognized authority on servomechanisms, he received the company's highest award for his work on a fully automatic gun fire control system.



Rapid Switching Time Test Set

Wilton Co. is marketing a switching time test set, Model 200, making possible the rapid and precise checking of switching times of transistors, diodes, and computer circuits. It is primarily aimed at computers with clock rates of from 1 MC to 100 MC. The device makes use of the "strobe scope" technique pioneered by Bell Labs which allows an automatic, continuous oscilloscope sync. and eliminates the need for delay cables.

It has built-in pulse sources, scope display, meter readout, bias supplies, and test jig. Time intervals from 1 nanosecond to 500 nanoseconds can be measured with accuracies of from 3 to 5%. Positionable marker bugs are provided which ride on the oscilloscope waveform and set the time interval for the meter readout. The built-in pulse sources allow a 2 MC test rate with 7 volts into 50 ohms with a 1.5 nanosecond rise time. A completely automatic version is available whereby only the insertion of diodes or transistors into the test circuit is done by hand. Both a voltage output and "Go, No-Go" lights are provided on this automatic version.

Circle No. 225 on Subscriber Service Card.

Universal Beam-X™ Module

Burroughs Corp. Electronic Tube Div., has available a Universal Beam-X™ Module (DC-112). This unit has counting, distributing, multiplexing and scanning capabilities. Outstanding among the features of this module is its ability to perform all these functions by merely reconnecting the input and output terminals.

The module, utilizing the general purpose Beam-X® switch (BX-1000), permits assembly of complex electronic digital systems with a minimum of original circuit design. When used as a counter, it provides direct drive for NIXIE® indicator tubes, printers, and other circuit devices without decoding matrices or amplifiers such as are required by other techniques.

Circle No. 226 on Subscriber Service Card.

Diversity Combiners

Telemetry diversity combiners in three models are available from Gulton Industries' Ortholog Division.

Used as accessory equipment to improve signal-to-noise ratios for telemetering systems, the combiners are designed to handle most types of signals, including PCM/FM, PDM/FM and FM/FM with band widths up to 5 mc.

The combiner has 2, 3 and 4 channel configurations, as indicated by the last number of the model designation —OR-DD/2, OR-DD/3 and OR-DD/4. Signal-to-noise improvements as high as 6 db, for four channels have been realized by the combiner, which can operate over input signal dynamic changes beyond 80 db.

Circle No. 227 on Subscriber Service Card.

Two-Dimensional Board

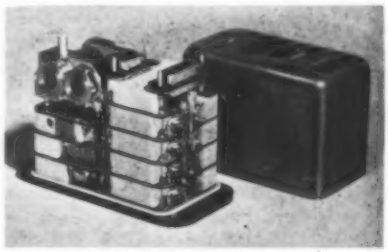
Spec-Tronics has available an all-purpose matrix printed circuit board. The pattern provides a complete set of physically perpendicular circuit connections on both sides of the board. Corresponding holes are provided at each intersection for wiring. These features, in conjunction with the standardized insertion strips, permit ready preparation of customary, cross-over, bus bar and transposition configurations.

Circle No. 228 on Subscriber Service Card.

Lightweight Command Receiver

An extremely miniaturized Veri-Min command receiver for control purposes in drones, pilotless aircraft and satellites, and for destroy purposes in missile range-safety operations, is available from Leach Corp.

The Veri-Min is a light (24 oz.), small (17.9 cu. in.) solid-state, dual conversion, super-heterodyne set designed to receive tone-modulated FM signals in the frequency range of 406 to 450 megacycles. The unit demodulates and filters the tone signals and



uses them to actuate control relays. It has low power consumption. In its standard form, it has four channels and contains four decoder assemblies, with supplemental packages to provide additional decoder channels.

Circle No. 229 on Subscriber Service Card.

Hyperthermal Wind Tunnel

A one-megawatt arc-heated hyperthermal test facility capable of accurately simulating critical reentry and ascent trajectories within the laboratory is being marketed by Plasmadyne, a

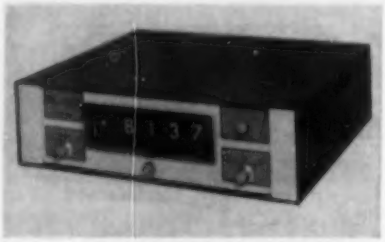
subsidiary of Giannini Scientific Corp.

Standard heat transfer simulation range of the facility using a 3.0 in. diameter Mach number 3 test section, is between 10,000 and 30,000 ft./sec. simulated force-flight velocity. Simulated altitudes are as low as 100,000 ft. at 10,000 ft./sec. and as low as 200,000 ft. at 30,000 ft./sec. At higher altitudes and reduced power levels simulation of velocity to 35,000 ft./sec. can be achieved.

Circle No. 230 on Subscriber Service Card.

Digital Voltmeter

Electronic Associates, Inc., is marketing the Series 5000 Transistorized Digital Voltmeter featuring very high input impedance that does not depend upon a null condition within the instrument. Solid state computer-type amplifiers are used in a unique loading circuit to achieve the "fulltime" high input impedance.



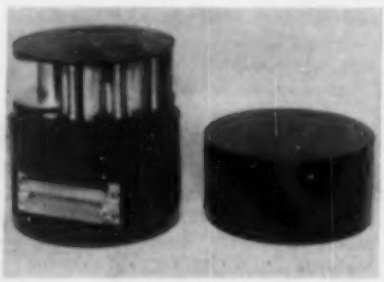
An average of 200 readings per second is achieved with a ±0.01% accuracy relative to either an external reference or the precise internal zener reference. A high brilliance in-line, in-plane projection readout is used to display the four-digit reading, decimal point and sign.

Circle No. 231 on Subscriber Service Card.

Miniature Tape Recorder

A Miniature Magnetic Tape Recorder, which simultaneously records data (1 to 14 channels, in line or interlaced) from tests conducted under severe environmental and extremely limited space conditions, is available from Aero Data Manufacturing Co.

Model TR-1875 is available in speeds of 1.875, 3.75, 7.5 and 15 inches per second, with a capacity of 150 feet of 1 Mil Polyester Instrumentation Tape providing up to 16 minutes recording. The wow and flutter under static conditions is less than 1%.



Circle No. 232 on Subscriber Service Card.

Missile TV Monitors

General Electric Co. has developed a series of television monitors which operate with any standard monochrome camera. The sets have an 800-line minimum horizontal resolution.

A design technique prevents interaction of controls. Thus, size, focus and linearity controls can be operated individually, and adjustment of one has no effect on the others. The monitors are equipped with a unique input circuit that substantially cancels out picture disturbance caused by surrounding high-current wires.

Circle No. 233 on Subscriber Service Card.

Four-In-One Welding Torch

Linde Co. has available a 500-ampere ST-5 torch for all four types of mig welding—spray arc, short arc, plug and spot welding. The versatile torch can be used with all "Sigmatic" mig welding machines, and features an in-line design—all service lines (gas, power, water and wire) enter the torch through the rear of the barrel. As a result, they can be supported on the welder's shoulder for balanced torch operation.

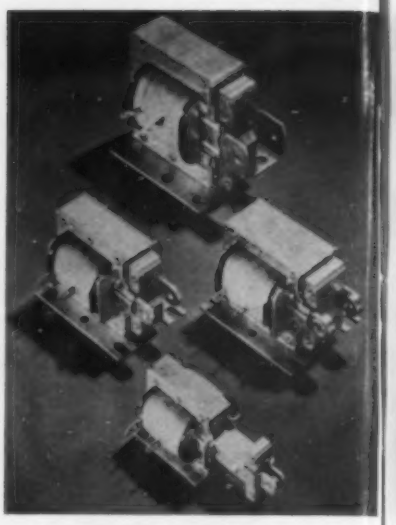
The ST-5 has a cooling system that brings water directly into the nozzle body to cool the contact tube, permitting continuous operation at currents as high as 500 amperes, even with carbon steel welding wire.

Circle No. 234 on Subscriber Service Card.

Improved Solenoid Line

Dormeyer Industries has available a Super-T Improved Line of Solenoids designed to replace the former CT Line.

The Super-T is a laminated solenoid, with superior electrical and mechanical characteristics, and has a stronger seating pull without excessive AC hum. The solenoids may be supplied with moisture resistant, moisture proofed or with coils completely encapsulated in epoxy resin for varying degrees of protection against humidity, water or oil spillage or physical damage.



Circle No. 235 on Subscriber Service Card.

Washaway Mandrels

Rezolin, Inc., has developed a complete procedure for producing washaway mandrels 3 in. in diameter and larger, for all types of pressure vessel fabrication with reinforced plastic.

The system utilizes hot-melt, water soluble Rezolin Paraplast materials which are slush molded in laminated epoxy molds. The completed mandrel has a hard, dense, ceramic-like surface that will withstand compressive forces of up to 19,000 p.s.i. The slush molding which can be accomplished in a matter of minutes produces an eggshell hollow-type structure which can be made to any desired thickness with a very uniform wall thickness.

Circle No. 236 on Subscriber Service Card.

Micro-Module Circuitry

A "789 Series" of sub-miniature encapsulated, transistorized digital and logic circuit modules, constructed of high reliability components is available from the Walkirt Co. These space-saving circuits have all been designed to meet stringent reliability needs; approaching micro-module size yet using only standard reliability-proved components with a mean time before failure (MTBF) of over 30,000 hours at 40°C and over 20,000 hours at 100°C for a typical Binary Counter. Other circuits have a MTBF of over 136,000 hours.

Circle No. 237 on Subscriber Service Card.

contracts

NASA

Minneapolis-Honeywell Regulator Co., from **The Martin Co.** for human factors studies in connection with *Apollo*. Amount not disclosed.

Radiation Incorporated, Melbourne, Fla., for furnishing the pulse code modulation telemetry system for the *Nimbus* satellite. Amount not disclosed.

$479,598—Systems Division of Beckman Instruments, Inc., Anaheim, Calif., for Model 210 data acquisition systems.

$350,000—The Siegler Corporation's Hallamore Electronics Division, Los Angeles, for design and manufacture of a television instrumentation system for *Centaur*. Subcontract from **Convair Astronautics Division of General Dynamics Corp.**

$150,000—Air Research and Development Command, Andrews AFB, for additional studies and design of *Saturn* rocket. Subcontract from **Marshall Space Flight Center.**

$79,220—Chrysler Corporation's Missile Division, Detroit, for study of corrosion and corrosion prevention in the *Saturn* rocket. Subcontract from **Marshall Space Flight Center.**

$40,710—Wyle Laboratories, El Segundo, Calif., for a high-accuracy mass flowmeter for use with liquid hydrogen.

NAVY

$28,177,129—Raytheon Co., Lexington, Mass., for production of the *Sparrow III* air-to-air supersonic missile.

$5,534,526—Remington Rand Univac Military Dept., St. Paul, Minn., for production of additional computer systems for the Naval Tactical Data System.

$2,119,900—Yardney Electric Corp., New York, for batteries to be used in electric homing torpedoes.

ARMY

$61,773,644—George A. Fuller Co. and Del E. Webb Construction Co., Los Angeles, for construction of operational *Minuteman* facilities at Malmstrom AFB, Mont.

$6,200,000—Western Electric Co., Burlington and Greensboro, N.C., for ground and test equipment for the *Nike-Hercules* missile system. Two contracts.

$2,700,000—Space Technology Laboratories, Inc., Los Angeles, 3-yr. contract to provide systems engineering support and technical consultant services on the *Advent* program.

$2,626,098—Nortronics Division of Northrop Corp., Anaheim, Calif., for *Hawk* missile system repair parts and launchers. Three contracts.

$1,510,872—Sperry Rand Corp., Salt Lake City, for *Sergeant* missile ground handling and test equipment.

$1,445,303—John W. Cowpar Co., Buffalo, N.Y., for construction of additional *Bomarc* facilities.

$258,695—Douglas Aircraft Co., Santa Monica, Calif., for *Nike* missile system spare parts.

$169,197—Sylvania Electric Products, Inc., Waltham, Mass., for study of research in coherent digital phased array radar system.

$139,667—Raytheon Co., Waltham, Mass., for concurrent repair parts for *Hawk* missile system.

AIR FORCE

Hughes Aircraft Co., Culver City, Calif., a multimillion-dollar contract from **The Martin Company** for technical assistance in activating a *Titan* ICBM base at Mountain Home, Idaho.

Space Electronics Corp., for theoretical and experimental investigation into ultra-low-frequency and sub-surface propagation of electromagnetic waves at long distances.

Boeing Airplane Co., from Advanced Research Projects Agency, for study of nuclear radiation for the Air Research and Development Command. Amount not disclosed.

$1,750,000—Tool Research and Engineering Corp., Beverly Hills, Calif., for stainless steel honeycomb core for the B70, and titanium fabrication and components for the *Hound Dog* missile programs. Subcontract from **North American Aviation.**

$984,152—Yardney Electric Corp., New York, for high-energy batteries to be used in the *Bomarc* missile.

$600,000—Federal Systems Division of International Business Machines Corp., Rockville, Md., for product and manufacturing engineering support for *Sage I* systems.

$29,868—Block Associates, Inc., Cambridge, Mass., for research in development and testing of new techniques pertaining to the design and utilization of rocket-borne spectroradiometric systems.

$26,614—Electro-Optical Systems, Inc., Solid State Division, Pasadena, Calif., for research and development in ultrarapid cooling techniques applied to beryllium alloys.

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NICAD DIVISION
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St. Paul 1, Minnesota

Circle No. 8 on Subscriber Service Card.

letters

Nike-Zeus Report

To the Editor:

So you're back in bed with the Army. Time magazine certainly tagged you properly on that. I see now that copies of your *Nike-Zeus* issue have been sent to President Kennedy and all the members of the House of Representatives. Why don't you stop plugging *Nike-Zeus* and go back to objective reporting?

Richard Lawrence
Philadelphia

The Nike-Zeus special report (M/R, Jan. 30) is the fourth special report on a missile system we have done in the past eight months. Others: Titan (Air Force), Minuteman (Air Force), Polaris (Navy). Nowhere in the Nike-Zeus report did we state an opinion on whether or not it should go into production.—Ed.

To the Editor:

I have read with great interest your issue containing the series of articles on the *Nike-Zeus* program.

You and your competent staff are to be congratulated for the clear and interesting exposition of a truly complex problem. By the analysis of each phase of the program, you have presented to your readers the full scope of the problem which confronts the President.

It is evident that many hours of thorough research and study have gone into your summation . . .

William W. Quinn
Major General, GS
Chief of Information
Department of the Army
Washington

To the Editor:

Congratulations on your recent special section on the *Nike-Zeus*. It is wonderful to have all that information on this important missile published.

I also have kept for my files your special report on the *Polaris* missile.

Lewis Cope
Richmond, Va.

To the Editor:

To help me in my work I am writing to ask for reprints of all the articles on the *Nike-Zeus* program.

W. T. Jackson
American Air Filter Co., Inc.
Los Angeles

Reprints of the Nike-Zeus report are available for twenty-five cents each from Reprints, MISSILES AND ROCKETS, *1001 Vermont Ave., NW, Washington 5, D.C.*

Space for Military

To the Editor:

Your editorial ("Earth Is for Peaceful Purposes," M/R, Feb. 20) said more on this subject in less than 500 words than everything previous on this subject combined. More than that, it was one hell of a sales argument for which the USAF owes you two chickens. I certainly admire the way you think—and *not* because I'm working for the AF, either

Joe Lucas
Cocoa Beach, Fla.

To the Editor:

I was most impressed with your editorial. Keep up the good work.

Congratulations.

Roy E. Marquardt
The Marquardt Corporation
Van Nuys, Calif.

Dyna-Soar Misgaged

To the Editor:

Our mailman is developing round shoulders as an indirect result of your article, "Special Gages Will Record Strain on Dyna-Soar" (M/R, Feb. 6, p. 30). Much of his load consists of letters from potential suppliers asking us if we have shut the door on strain gage competition, as the article seems to imply.

According to the lead paragraphs:

"Measurement of strain on *Dyna-Soar* during flight will be made by special strain gages . . . welded to the craft's surface . . . Microdot, Inc., producers of the device, utilize several unique construction and welding techniques . . . Typical of programs now using the gage are *Titan, Minuteman* . . ."

In the interest of Boeing-vendor harmony, I should like to point out that a specification document for *Dyna-Soar* strain gages has not even been released for quotations. No strain gages—Microdot's or anyone else's— will be selected for use on the *Dyna-Soar* glider until sometime in the future; certainly not until the results of qualification tests are known.

If your reporter was *not* referring to the *Dyna-Soar* glider, but to the modified *Titan* ICBM which will boost the glider, the point was not clear. Our stooped-back mailman is proof that a lot of other people took a flying leap at the same conclusion we did.

Now then, a word about the "use" of the Microdot gage in the *Minuteman* flight test program:

Microdot strain gages were evaluated at Boeing for possible application to the *Minuteman* flight test program. Another vendor was selected, however, and the Microdot strain gages have never been used on any portion of the *Minuteman* program for which Boeing is responsible. It is quite possible, of course, that some other *Minuteman* contractor may have used the gages during development tests.

All this will be verified by Microdot, with whose representatives we have discussed the subject several times.

R. William Jury
Public Relations Manager
Dyna-Soar Program
Boeing Airplane Company
Seattle

when and where

American Congress on Surveying and Mapping and American Society of Photogrammetry, Convention, Shoreham Hotel, Washington, D.C., Mar. 19-25.

IRE International Convention, Coliseum and Waldorf-Astoria Hotel, New York City, Mar. 20-23.

American Society for Metals, 12th Western **Metal Congress,** Ambassador Hotel and **Western Metal Exposition** in Pan-Pacific Auditorium, Los Angeles, Mar. 20-24.

23rd Annual American Power Conference, Sherman Hotel, Chicago, Mar. 21-23.

American Meteorological Society, General Meeting, Chicago, Mar. 21-23.

American Chemical Society, 139th National Meeting, St. Louis, Mar. 21-30.

4th Symposium on Temperature, Its Measurement and Control in Science and Industry, sponsored by ISA, American Institute of Physics, National Bureau of Standards, Veteran's Memorial Hall and Deshler Hilton Hotel, Columbus, Ohio, Mar. 27-31.

American Nuclear Society, Nucleonics in Flight Symposium, Statler Hilton Hotel, Dallas, Mar. 28-29.

Society of Aerospace Material and Process Engineers, Filament Winding Symposium, Huntington-Sheraton Hotel, Pasadena, Calif., Mar. 28-30.

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Advertisers' Index

Aerojet-General Corp., Sub-General Tire & Rubber Co. 52
Agency—D'Arcy Adv. Co.

American Steel Foundries, Hammond Div. 33
Agency—Edwin Wasey, Ruthrauff & Ryan, Inc.

Avnet Electronics Corp. 12
Agency—Dale & Finkels, Inc.

Bell Aerosystems Co., a Div. of Bell Aerospace Corp. 2
Agency—The Rumrill Co., Inc.

Consolidated Electrodynamics Corp. 39
Agency—Hixson & Jorgensen, Inc.

Delco Radio, Div.-General Motors Corp. 4
Agency—Campbell-Ewald Co.

Engelhard Industries, Inc. 47
Agency—Stuart Sande, Adv.

General Materials Co. 7
Agency—Ritter, Sanford, Miller & Kampf, Inc.

Gould-National Batteries, Inc. 47
Agency—E. T. Holmgren, Inc.

Haws Drinking Faucet Co. ... 44
Agency—Pacific Advertising Staff

Hercules Powder Co., Inc. ..26, 27
Agency—Fuller & Smith & Ross, Inc.

Hughes Aircraft Company .. 51
Agency—Foote, Cone & Belding

Kearfott Co., Sub.-General Precision Equipment Corp... 31
Agency—Gaynor & Ducas, Inc.

Kern Instruments, Inc. 13
Agency—Richmond Adv. Service, Inc.

Lockheed Aircraft Corp., Georgia Div. 6
Agency—Foote, Cone & Belding

McCormick Selph Associates.. 10
Agency—Long Advertising, Inc.

Minneapolis-Honeywell Regulator Co., Aeronautical Div. 8, 9
Agency—Foote, Cone & Belding

Mitre Corp., The 49
Agency—Deutsch & Shea, Inc.

New Departure Div.-General Motors Corp. 3
Agency—D. P. Brother & Co.

Northrop Corp. 20
Agency—Doyle, Dane, Bernbach, Inc.

Vickers Inc., Div.-Sperry-Rand Corp. 35
Agency—Gray & Kilgore, Inc.

Vitro Labs., a Div. of Vitro Corp. of America 25
Agency—Sam J. Gallay Adv.

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The chalk moves across the blackboard, pausing, crossing out... yet giving mathematical form to a new idea. This may be the beginning of a command and control system that will not be on-line until the 1970's. It is also the first step toward solving the many complex problems inherent in large scale system engineering.

Today, MITRE is active in every system area – from advanced design through prototype development to operational evaluation. Here your individual contribution – whether in command and control system engineering, air traffic control, or experimental electronic development – will be in the forefront of a new technology.

Appointments to MITRE's Technical Staff are currently being made in the following areas: **Operations Research • System and Sub-system Feasibility Studies • Prototype System Development • Advanced System Concepts and Design • System Cost Analysis • Operational Evaluation**

Inquiries may be directed to
VICE PRESIDENT – TECHNICAL OPERATIONS

THE MITRE CORPORATION

Post Office Box 31—12-WY—Lexington, Massachusetts

Senior members of MITRE's Technical Staff will be available for discussion at the Headquarters Hotel during the IRE Convention.

editorial . . .

The Goddard Memorial Trophy

EACH YEAR, the editors of this magazine face the task of selecting the outstanding achievement in the missile/space field during the previous year. To the person or group most responsible for that achievement goes the annual Goddard Memorial Trophy.

Selection of the winner is not a responsibility to be taken lightly. In the four years since it was instituted, the Goddard Trophy has taken on something of the stature in the missile/space field of the Collier Trophy in aviation.

The names of the men who have received it in the past are sufficient indication of that: Wernher von Braun, Samuel K. Hoffman and Karel J. Bossart—three of the industry's outstanding leaders.

This year, for the first time, the trophy is going not to an individual but to an entire organization. As announced in this issue, the winner is the Lockheed Missiles and Space Division.

There is excellent reason for the decision. There were two historic and outstanding achievements in the missile/space field during 1960:

–On Aug. 19, man for the first time recovered an object from orbit, the capsule from *Discoverer XIII*.

–On Nov. 15, the first *Polaris* missiles became operational with the sailing of the George Washington for its Atlantic station.

Recovery of the *Discoverer* capsule climaxed a long and successful program in which much of the real achievement had been overshadowed by the more spectacular efforts to achieve recovery.

The *Polaris* program not only resulted in the birth of a new weapon with a major strategic effect; it was without doubt one of the most successful development efforts ever undertaken on any weapon system.

Prime contractor on both these programs was, and is, the Lockheed Missiles and Space Division.

The Goddard Memorial Trophy, therefore, is going to LMSD for the teamwork and creative engineering which led to the two outstanding achievements in our field in the past year.

To be the driving force behind two such programs is something of which LMSD can be proud. Every person employed at the division can feel a glow of pride and accomplishment at being part of such a team.

When it is realized that only a few short years ago, there was no Lockheed Missiles and Space Division, that the fields where its major buildings now stand were in agricultural use, one can truly appreciate the magnitude of what has been accomplished.

To make the agile shift into the missile/space field required farsighted and courageous management. But it required more, much more. It required a truly dedicated engineering and production team to make the goals of management come true.

THIS AWARD is for all of them. For the executives who made those hard middle-of-the-night decisions, for the scientists who mapped out the parameters of the programs, for the engineers and draftsmen laboring over designs, for the secretaries who shuffled papers, for the girls on the assembly lines at Sunnyvale, for the men on the firing stands in the Santa Cruz mountains, for the crews who sweat out the bad ones and cheered the good ones at Canaveral and Vandenberg.

For all, an honor well-earned.

There are many of us who remember with a certain nostalgia Lockheed's wartime slogan: Look to Lockheed for Leadership. The team at LMSD has made us do just that.

We are certain the Air Force, the Navy and all the associate and subcontractors who worked on the two programs join us in saying:

Well done, Lockheed.

William J. Coughlin

putting Polaris on a precision path

Several new contracts for research and development of computer and guidance components for the Polaris Missile have recently been awarded to the Hughes Engineering Division. As a result, a variety of openings have been created for graduate engineers and scientists who have a minimum of three years experience specifically related to:

- Inertial Components and Platforms
- Systems Design and Physical Design of Inertial Devices
- Digital Computers
- Servomechanisms
- Controls Systems Analysis
- Magnetic Drum and Magnetic Core Circuit Design
- Transistor Switching and Circuit Design

Polaris Guidance is but one of the many R&D programs which reflect the growing emphasis on space oriented projects at Hughes. The Engineering Division is also responsible for such projects as: Space Ferry Systems, Anti-ICBM Detection Systems, Infrared Search Systems, and Communications Satellites.

For immediate consideration, please write, wire or call: **Mr. R. A. Martin**
Supervisor, Scientific Personnel
Hughes Aerospace Engineering Division
Culver City 13, California.

We promise you a reply within one week.

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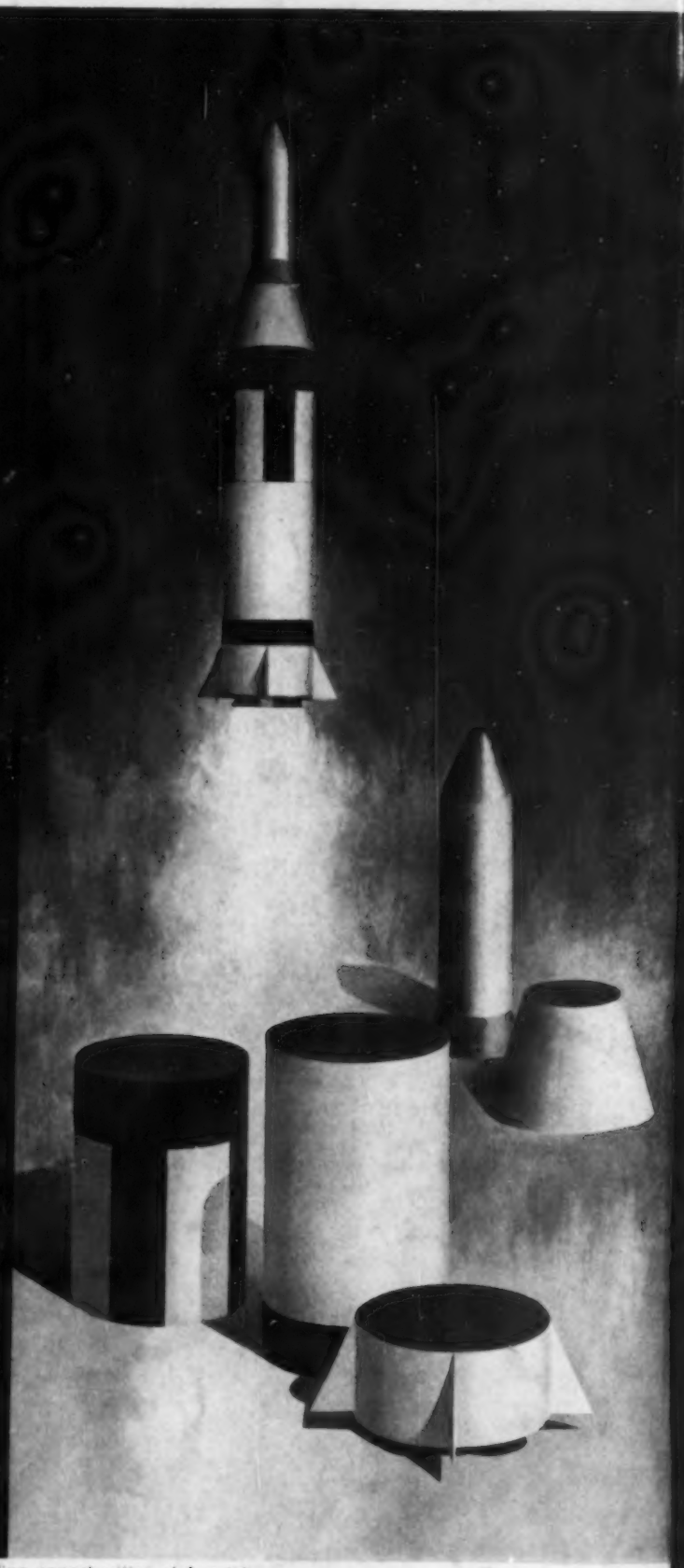

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